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HEPATITIS B AND C, HIV AND SYPHILIS AMONG MIGRANTS IN FINLAND

OPPORTUNITIES FOR PUBLIC HEALTH RESPONSE

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ACADEMIC DISSERTATION

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ABSTRACT

Increasing global migration influences the epidemiology of infectious diseases. Migrants are over-represented among cases of hepatitis B and C, HIV and syphilis in many European countries, including Finland. However, there is only limited evidence of the infection prevalence and risk factors among migrant populations as well as on the effectiveness of approaches for prevention and early diagnosis.

The aim of this study was to describe the burden of hepatitis B and C, HIV and syphilis among migrants in Finland, and to evaluate opportunities for public health response. The study objectives were to describe the feasibility of screening in a migrant population-based survey context, to estimate the seroprevalence of infections, to evaluate the implementation of screening, and to assess HIV-related health literacy among specific migrant populations.

The data were collected from three surveys and from two national registers. The Migrant Health and Wellbeing Survey (Maamu) invited randomly selected adult migrants of Kurdish, Russian and Somali-origin to undergo screening for hepatitis B and C, HIV and syphilis. The survey sample was linked to the national infectious disease register to assess non-participation and previous notifications. The coverage and timing of hepatitis B, HIV and syphilis screening among all asylum seekers in Finland in 2015–2016 was assessed based on register information of healthcare procurements. HIV-related knowledge, attitudes and practices were compared between a convenience sample of 20 to 25-year-old asylum seekers originating from Africa, Middle East and the former Soviet Union, and a random sample of age-matched general population in Finland.

Provider-initiated multiphasic screening of hepatitis B and C, HIV and syphilis proved feasible in a migrant population-based health survey context. Notification prevalence of hepatitis B or C, HIV or syphilis did not differ among participants and non-participants of the survey. Acceptability of HIV testing was increased by enhanced pre-test counselling.

Hepatitis B and C, HIV and syphilis seroprevalence rates among the Kurdish, Russian and Somali-origin migrants and asylum seekers were in general comparable to or lower than in their countries of origin, but higher than among the general population in Finland. In the Maamu survey, seroprevalence of hepatitis B surface antigen (HBsAg) was 2.3%, hepatitis C antibodies (HCVAb) 1.7%, and Treponema-specific antibodies (TrpaAb) 1.3% among adult Kurdish, Russian and Somali-origin migrants. No cases of HIV were identified. The burden of hepatitis B was highest among Somali-origin migrants and that of hepatitis C and syphilis among Russian migrants. Among asylum seekers, HBsAg seroprevalence was 1.4%, HIVAgAb 0.3%,

and TrpaAb 1.0%. HCVAb and TrpaAb seroprevalences increased with age both among resident migrant and asylum seekers.

The coverage of after-arrival infectious disease screening was 87.5% among screening-eligible Kurdish, Russian and Somali migrants, and 60.6% among asylum seekers in Finland in 2015–2016. Previous HIV testing was reported by 31.4% of the Maamu participants and was associated with female gender. Previous HIV testing was reported by 23.4% of the young adult asylum seekers and 18.0% of the young adult general population.

Of all test-positive cases in Maamu, 60.7% had no previous notification in the national infectious disease register and were considered as missed diagnoses. The burden of missed hepatitis C and syphilis was high among Russians, the largest migrant population in Finland. The majority of Russian-origin migrants are not targeted by current screening recommendations for asylum seekers and refugees. Missed hepatitis B diagnoses among the Somali-origin migrants suggest hepatitis B infections post-migration. The average delay from arrival to screening was 47 days for asylum-seeking children and 91 days for adult asylum seekers in 2015–2016.

HIV-related knowledge was below the international target level among young adult asylum seekers. Asylum seekers preferred passive sources of HIV information to interpersonal strategies of health education.

In conclusion, although asylum and integration processes are windows of opportunity for health education, prevention and screening, barriers hindering their implementation exist. Findings from this study suggest opportunities for further research and public health response addressing vulnerabilities to hepatitis B and C, HIV and syphilis among migrants in Finland. These opportunities include extending after-arrival screening of hepatitis B, HIV and syphilis to target all at-risk migrants, inclusion of hepatitis C screening, describing and addressing barriers hindering implementation of screening, enhancing provider-initiated screening, investing in health literacy, and ensuring a continuum of care for all migrants.

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Tiittala P; Ristola M; Liitsola K; Ollgren J; Koponen, P; Surcel, H-M; Hiltunen-Back E; Davidkin I; Kivelä P. Missed hepatitis B/C or syphilis diagnosis among Kurdish, Russian or Somali origin migrants in Finland; linking population based survey to national infectious disease register. BMC Infectious Diseases. 2018 Mar 20;18(1):137.

II Tiittala P; Kivelä P; Ristola M; Surcel H-M; Koponen P; Mölsä M; Ollgren J; Liitsola K. Achieving high acceptability of HIV testing in a population-based survey among immigrants in Finland. Scandinavian Journal of Public Health. 2015 Jun;43(4):393-8.

III Tiittala P; Tuomisto K; Puumalainen T; Lyytikäinen O; Ollgren J; Helve O. Public health response to large influx of asylum seekers: implementation and timing of infectious disease screening. BMC Public Health. 2018 Sep 24;18(1):1139.

IV Tiittala P; Kivelä P; Liitsola K; Ollgren J; Pasanen, S; Vasankari T; Ristola M. Important gaps in HIV knowledge, attitudes and practices among young asylum seekers in comparison to the general population. Journal of Immigrant and Minority Health. 2018 Dec;20(6):1415-1423.

The publications are referred to in the text by their Roman numerals.

ABBREVIATIONS

ANS	antenatal screening
ART	antiretroviral therapy
HCVAb	hepatitis C virus antibody
CCOR	current country of residence
CDC	Centers for Disease Control and Prevention
CHB	chronic hepatitis B
CHC	chronic hepatitis C
CI	confidence interval
ECDC	European Centre for Disease Prevention and Control
EEA	European Economic Area
EU	European Union
FSU	Former Soviet Union
HBcAb	hepatitis B core antibody
HBsAb	hepatitis B surface antibody
HBsAg	hepatitis B surface antigen
HBV	hepatitis B virus
HCV	hepatitis C virus
HIV	human immunodeficiency virus
HIVAgAb	HIV antigen and antibody
IDU	injecting drug use
KAP	knowledge, attitudes, practices
Maamu	Migrant Health and Wellbeing Survey
MSM	men who have sex with men
MTCT	mother-to-child transmission
NAAT	nucleic-acid amplification test
NGO	non-governmental organization
NIDR	National Infectious Disease Register
(a)OR	(adjusted) odds ratio
PIC	personal identity code
PICOT	population, issue, comparison, outcome, type of study
PIS	population information system
PITC	provider-initiated testing and counselling
PLWH	people living with HIV
PWID	people who inject drugs
RNA	ribonucleic acid
SRH	sexual and reproductive health
SSA	Sub-Saharan Africa
STI	sexually transmitted infection
TB	tuberculosis
TrpaAb	*Treponema pallidum*-specific antibody
UNGASS	United Nations General Assembly Special Session

VFR	visiting friends and relatives
WAD	Worls Aids Day
WHO	World Health Organization

1 INTRODUCTION

Migration, urbanization, demographic change, global warming and digital and technical revolution are interlinked global megatrends that influence societies, economies, culture and health, including epidemiology of infectious diseases [1, 2]. The number of international migrants is continuously increasing and migration has become a complex and multidirectional phenomenon [3].

In many European countries, including Finland, migrants are overrepresented among cases of hepatitis B and C, HIV and syphilis [4, 5]. To an extent the higher burden of infections among migrants can be explained by pre-migratory factors: epidemiology of infections in countries of origin and transit and poor healthcare coverage amongst other social determinants of migrant health. Poverty is a major driver of poor health including infections [6-9].

An increasing body of evidence suggests that migrants' vulnerabilities to infection are not properly addressed in current countries of residence and there is on-going transmission post-migration. Public health policies disproportionately limit the access, affordability and availability of health services for migrants and preventive measures fail to reach those at risk [10, 11].

Hepatitis B and C, HIV and syphilis are blood-borne and sexually transmitted infectious diseases characterized by relatively long asymptomatic phases of latency, severe sequala, and availability of treatment that can considerably decrease the infection-associated morbidity, mortality and prevent further transmissions. Hepatitis B infections can be prevented with vaccinations. Screening of asymptomatic individuals is the key for early diagnosis, treatment and prevention of hepatitis B and C, HIV and syphilis. [12]

Facing these global trends in population dynamics, public health systems need to adapt to the service needs of the diverse and multicultural population. This study describes the burden of hepatitis B and C, HIV and syphilis among selected migrant populations in Finland, and evaluates strategies for prevention and early diagnosis of infections.

2 REVIEW OF THE LITERATURE

2.1 MIGRATION, HEALTH AND INFECTIOUS DISEASES

2.1.1 DEFINITIONS

The International Organization for Migration (IOM) defines a migrant as a "person who is moving or has moved across an international border or within a State from his/her habitual place of residence" [13]. Long-term residency is the result of migration lasting at least one year, as opposed to tourism or other short-term mobility [14]. Labour migrants are persons who migrate for the purpose of seeking employment [13].

Asylum seekers are persons seeking for international protection in a foreign country and awaiting a decision on the application of refugee status [13]. Refugee status is established by governments based on the 1951 Convention relating to the Status of Refugees and supported by United National Refugee Agency (UNHCR) if necessary [15, 16]. UNCHR-recognized refugees needing most urgent help are selected in the annual refugee quota in Finland [17]. Irregular migration refers to migration outside the regulatory norms of sending, transit and receiving countries [14].

Categorical determinants for migrant origin include country of origin, country of birth, nationality, ethnicity, race and native language amongst others. Country of birth is the most commonly used indicator of migrant origin in Finland as well as other European Union (EU) countries. [18, 19] Country of origin is defined by several population databases, including Statistics Finland, as the parents' country of birth [20].

Keeping in mind the complexity of migration trajectories, it is of note that country of birth might differ from country of origin, nationality and prior country of residence. Any single definition of a migrant rarely applies at an individual level [7]. The majority of European population databases do not record reasons for migration [18]. Other definitions for domestic and circular migration have been adopted in the scientific literature [21, 22]. This thesis will focus on first-generation international migrants defined as persons with foreign origin born abroad.

2.1.2 TRENDS IN MIGRATION AND DISPLACEMENT

Migration is a global megatrend that has multi-faceted impacts on individuals and societies. Migration patterns are increasingly complex and diverse, and are specific to location, time and population. Most countries in the world are both sending and receiving migrants. [3]

Migration is a circular process from country of birth to subsequent countries of residence and possible return [18]. Migration circles take place at varying speed, repeatedly and are integrated within the lifecycle of an individual [1, 18, 21]. Push and pull factors influence the decision to migrate and include economic, social, environmental, conflict-related and political dimensions [23]. Migration decisions range from voluntary to forced migration [1].

The global number of international migrants has almost tripled since the 1970s [3]. Migrants represented 3.4% (258 million) of the world population in 2017 and the majority of them resided in Asia (80 million) and Europe (78 million) [24]. Migration corridors differ between countries and regions, have developed through history and are shaped by economic factors, public policies, conflict, ethnic ties and trafficking [3]. Globally, almost three quarters of migrants were adults of working age (20 to 64 years) [24]. Labour migration is the major driver of global migration accounting for two-thirds of all international migrants [3].

In 2017, 68.5 million persons were forcibly displaced and 26 million had fled across an international border, representing one-tenth of international migrants globally [25, 26]. Children under 18 years of age represented 52% of the refugee population. The major source countries of refugees in 2017 were Syria, Afghanistan and South Sudan, and neighbouring countries Turkey, Pakistan and Uganda were the top receiving countries. [26] During 2015–2016, Europe faced a large influx of 2.6 million asylum seekers with Germany, Italy and Sweden receiving the largest number of applications [27, 28]. The number of migrants in irregular situations in the EU in 2008 was estimated at 2–8 million [3].

The majority of international migrants move between countries of the same region, as in case of Europe where 67% of migrants (41 million) are born in other European countries. In Europe, 10.5% of the total population in 2017 were migrants, of whom 52.0% were women. [24] Germany, the United Kingdom and Spain had the largest number of migrants in EU/EEA in 2016 whereas Luxembourg, Malta and Cyprus had the largest migrant populations relative to number of inhabitants [29].

In Finland, 5.8% (321,494) of the population in 2017 were international migrants. The largest migrant populations originated from Former Soviet Union (FSU) or Russia (71,601), Estonia (43,607), Iraq (16,306) and Somalia (12,121). Males were 51.3% of the migrants and 85.3% were in working age between 15 and 64 years. Migrants were concentrated in urban areas and more than half lived in the Helsinki and Uusimaa region. [30] In 2015–2016, the number of asylum seekers to Finland increased nearly ten-fold with the relative increase being among the highest in Europe. The majority of these asylum seekers were born in Iraq, Afghanistan and Syria, and a quater of them were children. [31]

2.1.3 MIGRATION, HEALTH AND INFECTIOUS DISEASES

Migration has various impacts on health on an individual level among the migrants and on a population level both in the countries of origin and destination [2, 6, 7, 18]. Immigration of healthy migrants and "brain gain" of health professionals are examples of population health benefits of migration [7, 18]. On the other hand, migrants might have specific vulnerabilities that translate into increased morbidity. Forced migration typically exacerbates the health risks especially among the vulnerable populations: children, women, elderly and the disabled [1]. Reports on migrant health are dependent on the heterogeneity of the migrant populations, reference groups and health concerns of interest [2, 4, 19].

Epidemiology of infectious diseases is influenced by interlinked global megatrends of globalization, population movements and environmental changes. Air travel enables human, livestock, food as well as accompanying infections to cross the globe within hours. Population movements induce demographic changes and the risk profiles for infection might differ between the newcomers and the native populations. Moreover, environmental changes linked to global warming and urbanization might facilitate the emergence of some infections, especially zoonoses. [19, 32]

On an individual level, migrants' health and risk for infectious diseases is influenced by various determinants for health, some of which are migration-specific (Figure 1) [2, 6, 21, 23, 33-35]. Some of the migration-specific determinants for health occur only at certain phases of the migration cycle. Some –- such as health system coverage –- are present at every phase of the transition. [19]

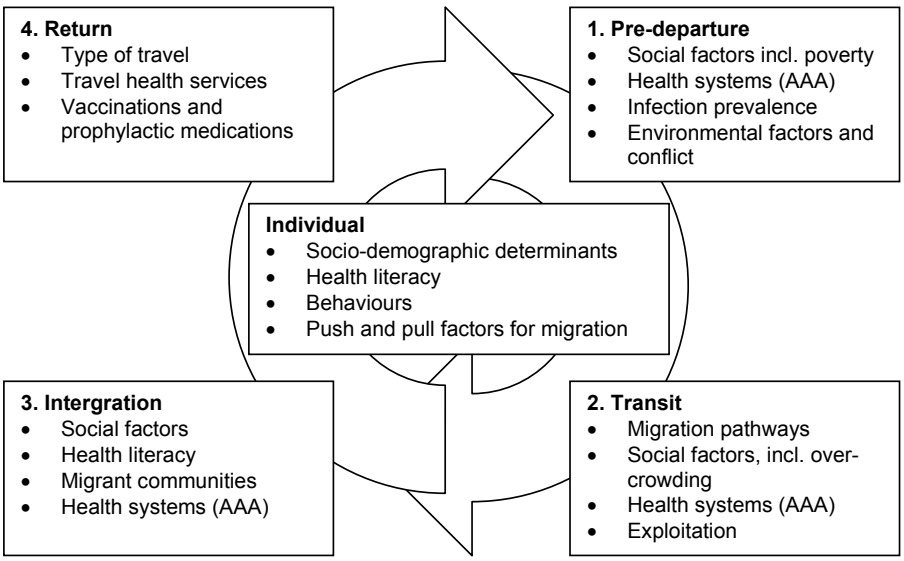

Figure 1 Socio-demographic determinants for infectious diseases among migrants at four steps of the migration cycle [2, 6, 7, 21, 23, 33-36]. AAA = Access, Affordability, Availability.

Migration has increased the heterogeneity of epidemics of blood-borne and sexually transmitted infections in Europe as epidemiological characteristics such as transmission mechanisms partly differ between native and migrant populations, [37, 38]. In most high-income, low-prevalence countries migrants are disproportionally affected by blood-borne and sexually transmitted infections and have become a key population for public health responses [4, 39-42]. Migrants are not considered to pose a threat to the spread of infectious diseases among the general population but are, however, themselves vulnerable to infections [9, 11]. For example, a Dutch modelling study showed that migration influences above all the risk of HIV spread among migrants [43].

Migration poses challenges to infectious disease surveillance since current surveillance and reporting systems are not well-adjusted to observe patterns of population movements [4, 34, 44, 45]. As an example, only a small minority of EU/EEA countries are able to monitor the continuum of HIV care among migrants [46].

2.2 BASICS OF HEPATITIS B AND C, HIV AND SYPHILIS

Hepatitis B and C, HIV and syphilis are categorised as blood-borne and sexually transmitted infections as they are caused by micro-organisms that are transmitted either directly or indirectly from human to human through blood and during sexual contact. Direct transmission occurs during intimate contact or vertically from mother to child during pregnancy, delivery or breast-feeding (MTCT). Indirect transmission can occur through injecting drug use (IDU) or iatrogenically contaminated medical equipment or blood products. [12, 47, 48]

2.2.1 BASICS OF HEPATITIS B

Hepatitis B is a viral hepatitis infection caused by a double-stranded DNA-virus belonging to the *Hepadnaviridae* family. Eight major viral genotypes (A to H) have been identified [49]. Hepatitis B virus (HBV) was first identified as a causative agent of serum hepatitis in 1965 [50].

A third of acute infections are symptomatic and less than 1% result in fulminant acute hepatitis B [50]. Extrahepatic manifestations of infection also occur [50]. Development of chronic hepatitis B (CHB) is inversely associated with age; 90% of perinatally infected neonates develop CHB in comparison to less than 5% of newly infected adults [51, 52] Spontaneous transition occurs between the four clinical phases of CHB: immune-tolerance, immune-clearance, immune-control and immune-escape [49-51, 53].

Prognosis of CHB is influenced by HBV viral load, infection activity, viral genotype, age, gender, genetic factors, as well as other comorbidities and risk behaviours and is directly related to the development of cirrhosis [12, 50, 51, 54]. Approximately 20–30% of the people living with CHB develop severe

sequelae: liver dysfunction, cirrhosis and hepatocellular carcinoma [50, 55]. The five-year cumulative probability of developing cirrhosis among HBsAg-positive ranges from 8 to 20% and five-year survival among patients with HBV-induced cirrhosis between 30–85% [12, 49].

HBV is transmitted through blood, sexual contact or saliva [12]. MTCT and early-childhood horizontal transmission are the most common modes of transmission in high-prevalence areas whereas in low-prevalence settings, HBV transmits typically through sexual contact or percutaneously [50].

Screening of CHB is often based on the serological detection of surface antigen (HBsAg). A combination of different HBV-specific antigens and antibodies, and HBV-DNA, are used to identify different phases of HBV infection and determine whether a person is immune to HBV [12, 49, 55]. Hepatitis B vaccine has been available for primary prevention globally since 1982 and was included in the national vaccination program in Finland in 1993 [56, 57]. In 2009 the World Health Organization (WHO) recommended universal hepatitis B vaccination of all infants [58]. Hepatitis B immunoglobulin in conjunction with hepatitis B vaccine can be administered for post-exposure prophylaxis [12, 55].

Nucleoside or nucleotide analogue and interferon-based therapy is available for the treatment of CHB [59]. Usually indefinite regimen is required but treatment cessation might be considered for some patients [59]. WHO recommends antiviral treatment of CHB for patients with cirrhosis or with CHB/HIV-coinfection, and for adults presenting with high viral activity [55].

2.2.2 BASICS OF HEPATITIS C

Hepatitis C infection is caused by a single-stranded RNA-virus belonging to the *Flaviviridae* family. Hepatitis C virus (HCV) infects mainly liver cells. [60] The virus was first identified in 1989 [61]. Seven HCV genotypes have been identified with distinct distribution according to geographical origin and transmission mode [60, 62].

Acute hepatitis C is asymptomatic in 90% of those infected and fulminant acute hepatitis is rare. Approximately 20% resolve the infection spontaneously. [60] Approximately 10–40% of those with chronic hepatitis C (CHC) will develop disease sequelae namely fibrosis, hepatocellular dysfunction, cirrhosis, and hepatocellular carcinoma [60, 63]. Extra-hepatic manifestations occur in 38–76% of patients with CHC [12, 60, 64].

Disease progression has been associated with older age, male gender, elevated transaminases, viral genotype, HBV and HIV coinfection and excessive alcohol intake [60, 61, 64]. Of patients with CHC-related cirrhosis, 1–5% will develop hepatocellular carcinoma annually. The development of carcinoma has been associated with level of HCV viremia, activity of the hepatitis and viral genotype. [63]

Hepatitis C is mainly transmitted through unsafe medical procedures and injection equipment [65]. The probability of MTCT is 3–10% [60, 65]. Risk of heterosexual transmission of HCV has been estimated below 5% per sexual contact. Increasing numbers of HCV transmissions among non-IDU men who have sex with men (MSM) especially in the presence of HIV coinfection have been reported globally during the last decades. [66]

Detection of antibodies to HCV (HCVAb) is used for screening and CHC diagnosis is based on identification of HCV RNA [64]. WHO recommends evaluation of all HCV-infected for treatment and from 2015 the direct-acting antivirals have become the standard of care [60, 67]. Direct-acting antivirals are highly effective in achieving sustained virological response among different HCV genotypes in over 90% of patients but more evidence is needed to support long-term benefits on HCV-related morbidity and mortality [68, 69].

2.2.3 BASICS OF HIV

Human immunodeficiency virus (HIV) infection is caused by a single stranded RNA-virus belonging to the *Retroviridae* family [12]. Two types of virus (HIV-1 and HIV-2) have been identified. HIV-1 is divided into four groups. HIV-1 group M viruses cause the majority of infections globally and are further categorized into subtypes and circulating recombinant forms that have distinct geographical distributions. [70]

HIV targets CD4-positive T-lymphocytes leading to a depletion of the CD4-positive cell reservoir and immune dysfunction, and is accompanied by a generalized immune activation [71, 72]. There are three stages of HIV infection: acute, chronic and acquired immunodeficiency syndrome (AIDS). Acute HIV infection might involve flu-like symptoms [73]. AIDS, the most advanced stage of HIV infection, is characterized by the presence of opportunistic illnesses [73-75].

Natural disease progression varies greatly between individuals and especially age at seroconversion [71, 73, 76]. Median time of survival after HIV seroconversion without treatment is approximately 10 to 12 years [76].

Although sexual transmission of HIV is the major mode of HIV transmission globally, the probability of infection per sexual contact is low, ranging between 0.003% and 7.5% with highest risk associated with receptive anal intercourse [12, 73]. HIV is transmitted more effectively through blood transfusion (estimated risk over 90% per contact), MTCT (23–40%) and needle sharing (0.63%) [73, 77]. Risk of sexual transmission of HIV is increased by high HIV viral load, presence of other sexually transmitted infections, pregnancy and lack of male circumcision [12, 72].

Diagnosis of HIV is based on detection of HIV-specific p24 antigen and antibodies (HIVAgAb). Nucleic acid amplification test (NAAT) is used in assessment of a recent HIV infection and MTCT. [73] Plasma viral load and CD4 count are used for staging of the infection and monitoring of treatment [71, 73].

Since the introduction of zidovudine in late 1980s, there has been a dramatical increase in the availability, efficacy and tolerability of new classes of antiretroviral drugs [72, 73, 78]. Antiretroviral therapy with combination regimen of antiretroviral drugs (cART) significantly reduces HIV-related morbidity and mortality, and prevents further transmission [78, 79]. The life expectancy of HIV-infected individuals on cART is estimated to be nearly the same as for non-HIV-infected persons especially if cART is initiated early, adherence to treatment is high and other risk factors are controlled [78]. Current guidelines recommend universal initiation of cART after diagnosis irrespective of the clinical stage of the disease or CD4 count [79, 80].

2.2.4 BASICS OF SYPHILIS

Syphilis is a bacterial infection caused by *Treponema pallidum* subspecies *pallidum* spirochete and is related to other pathogenic treponemes that cause non-venereal infections [81, 82].

Clinically syphilis can be classified into incubating, primary, secondary disseminated, latent and tertiary late phases. Primary syphilis involves the development of a painless ulcerative lesion at the site of inoculation. [12] At secondary stage, syphilis spirochetes disseminate in the body and parenchymal, constitutional and mucocutaneous manifestations can occur [12, 83]. Clinical manifestations of syphilis are absent in the latent phase [83]. Tertiary phase symptomatic syphilis is characterized with severe sequelae including cardio-vascular and neurological complications [82, 83]. If untreated, 15–40% of syphilis infected will develop late complications [83]. Congenital syphilis has been associated with higher risk of stillbirth, prematurity and neonatal death and more than half of pregnancies in women with syphilis will develop adverse outcomes [84].

Sexual transmission of venereal syphilis takes place through lesion contact during primary or secondary phases of infection [82, 83]. MTCT can occur at any phase of the infection [81, 83]. Blood-borne transmission of syphilis is rare [83].

Diagnosis through direct detection of syphilis spirochete is possible during primary, secondary and early congenital phases of infection using dark field microscopy, direct immunofluorescence or NAAT [12, 85, 86]. Serological testing is used at every stage of the infection. The traditional algorithm for syphilis serology testing combines a non-treponemal screening test with a treponemal confirmatory test. A reverse algorithm applies the opposite [85-87]. Non-treponemal tests, such as Venereal Disease Research Laboratory test, use non-treponemal reagins (cardiolipin, lecithin, cholesterol) whereas treponemal tests, such as treponemal agglutination or immunoassays, apply *Treponema*-derived reagins (lysates or recombinant antigens) [85]. In Finnish antenatal screening (ANS), the reverse algorithm

replaced syphilis screening with non-treponemal tests (Venereal Disease Research Laboratory test, Cardiolipin) in 2005 [87, 88].

Benzathine penicillin is recommended as the first-line treatment for syphilis [12, 89].

2.2.5 COINFECTIONS

Coinfections of hepatitis B and C, HIV and syphilis influence disease prognosis and morbidity. Most significantly HIV accelerates the natural history of hepatitis B and C, and syphilis [51, 65]. Interactions among CHB/HIV-coinfected are two-directional; HIV/CHB coinfection is associated with increased risk of liver-related mortality compared with either monoinfection alone, and vice versa; several studies indicate that underlying HBV infection also accelerates HIV progression and related morbidity [90].

Patients with CHC/CHB or CHC/HIV coinfections have increased risk for developing liver fibrosis and cirrhosis [65, 91]. The probability of MTCT of HCV is increased among mothers with HIV [60]. Patients with HIV/syphilis coinfection present with higher viremia, lower CD4 counts, persistent primary and secondary syphilis and rapid progression to tertiary syphilis [12, 83].

2.3 EPIDEMIOLOGY OF HEPATITIS B AND C, HIV AND SYPHILIS

In many low-prevalence countries, migrants are disproportionally affected by blood-borne and sexually transmitted infections [4, 92, 93]. However, assessments of infectious disease burden among migrants face several biases resulting in both under- and over-estimation of the burden [94]. Incidence data are essentially dependent on testing strategies [95].

2.3.1 EPIDEMIOLOGY OF HEPATITIS B

Globally, approximately 250 million persons have CHB and global overall HBsAg seroprevalence was 3.6% in studies performed in 1957–2013 [96]. A recent modelling study concluded a similar prevalence for 2016 at 3.9% [97]. The majority of the infected are male [98, 99]. In 2016, over 400,000 suffered from hepatitis B-associated carcinomas and 686,000 persons died of hepatitis B-related complications in 2013 [100, 101].

Trends in CHB prevalence over time are heterogeneous across regions and currently the most affected areas are Western-Pacific (over 95 million infected) and Africa (over 75 million infected) [96, 102, 103]. Countries can be divided into categories based on very low (<0.5%), low (<2%), low intermediate (2–4.99%), high intermediate (5–7.99%) and high (≥8%) CHB endemicity [55, 92].

Population growth and ageing result in increasing global CHB burden despite the decreasing hepatitis B incidence achieved with vaccinations [101, 103]. Less than 10% of those infected with CHB are estimated to have been diagnosed [104]. Approximately 10% of HIV patients are coinfected with CHB and 5–20% of patients with CHB are concurrently infected with HCV [50, 90, 105].

Migrants in low CHB prevalence countries have a significantly higher CHB burden than other risk groups, such as people who inject drugs (PWID). A systematic review and a meta-analysis estimated an overall global HBsAg seroprevalence among migrants at 7.2% with highest prevalence rates among migrants from highly endemic regions, namely East Asia and Pacific and Sub-Saharan Africa (SSA). [106] Another meta-analysis found an HBsAg prevalence of 3.5% among migrants to the USA [107].

Europe is considered a region with low CHB endemicity [96, 103]. CHB prevalence in Europe has been estimated at 1.8–2.1% with 13 to 18.5 million individuals infected [41, 96, 108]. CHB prevalence among general populations in the EU/EEA was estimated at 0.9% as two-thirds of the CHB cases in Europe live outside the EU/EEA area [40, 108, 109]. Notification incidence of CHB in EU/EEA has steadily increased, standing at 8.7 per 100,000 in 2016 [110, 111]. Conversely, the incidence of acute hepatitis B decreased in the EU/EEA during the last two decades, most likely due to increasing vaccination coverage [111, 112]. Among the notified HBV cases in 2016, male-to-female ratio was 1.7:1 and nearly a third was identified among 25–34 year olds [111].

Heterosexual transmission was the most common (30.2%) mode of transmission for acute hepatitis B in EU/EEA in 2016. For CHB, nosocomial (32.6%) and MTCT (31.6%) transmissions were most prevalent although the completeness of information on transmission mode was poor. [111] The highest HBsAg seroprevalence in EU/EEA has been observed among incarcerated persons (0.3–25.2%), PWID (0.5–6.1%) and MSM (0–1.4%) [113].

In EU/EEA every fourth CHB infection was estimated to affect migrants from HBV-endemic countries [40, 92]. Previous reports have shown HBsAg seroprevalence rates among migrants in Europe to range from 1.0 to 15.4% and overall HBsAg seroprevalence among migrants from endemic countries in the EU/EEA was estimated at 5.5% [40, 41, 114]. Migrants from endemic countries are considered the most important risk population for MTCT of HBV in EU/EEA [115].

In Finland, prevalence of CHB among the general population is assumed to be very low (<0.2%) although no recent seroprevalence assessments among the general population are available [110, 116]. HBsAg seroprevalence was 0.14% among pregnant women in 2005–2009 [88]. During 2004–2012, 59.8% of CHB cases were notified among men, 81.5% had a foreign origin and 3.3% had a HCV coinfection [57]. In 2017, notification incidence of CHB was 4.7 per 100,000 [5].

To date, no studies have assessed the CHB prevalence among general migrant populations in Finland; however two meta-analyses have provided

an indication. Rossi et al. provided an estimate of 6.4% CHB prevalence among all migrants whereas Ahmad et al. estimated a 5.7% CHB prevalence among migrants from HBV-endemic countries (HBsAg ≥2%) in Finland [40, 106]. Three percent of pregnant migrant women in irregular situations in Helsinki during 2014–2018 were diagnosed HBsAg positive [117].

2.3.2 EPIDEMIOLOGY OF HEPATITIS C

Global age-adjusted general population HCVAb seroprevalence was estimated to have increased from 2.3% in 1990 to 2.8% in 2005 among studies published during 1980–2007 [118]. A more recent review of studies published in the 21st century reported 2.0% HCVAb prevalence among general population adults and 1.6% among all age groups. The prevalence of viremic CHC among all ages was estimated at 1.1%, corresponding to 80 million chronically infected. [119] According to the Global Burden of Disease Study, CHC accounted for 704,000 deaths in 2013 and nearly 200,000 developed CHC-associated carcinomas in 2016 [100, 101].

The highest CHC prevalence has been reported in Central and East Asia, Middle East and North Africa, and China, Egypt, India, Nigeria, Pakistan and Russia account for more than 50% of all infections globally [118, 119]. Regional differences in CHC prevalence are explained by demographic differences, concentration of cases in certain age groups or sub-populations, transmission patterns and coinfection with HIV [61, 118, 119]. The proportion of infected children is higher in low-income countries (54%) compared to high-income countries (4%) [119].

Countries can be divided into categories based on HCV prevalence among the general adult population: very low (<1%), low (1–2%), intermediate (2–3%), high (3–5%) and very high (>5%) endemicity [120]. The European Centre for Disease Prevention and Control (ECDC) defines countries as having low (<1%) or high (≥1%) HCV endemicity [92].

Globally, the most CHC-affected populations include injecting and other recreational drug users, patients frequently receiving blood products, paid blood donors and incarcerated and homeless persons [61, 119, 121]. Global HCVAb seroprevalence among migrants from intermediate or high HCV-endemic countries was estimated at 1.9%, with highest seroprevalence rates among migrants from South Asia, SSA and Eastern Europe [120].

Global HCV incidence has decreased during the last decades mostly due to developments in harm reduction services and improved blood and injection safety. However, due to population growth and ageing, the overall HCV disease burden has increased since 1990. [101] Up to 80% of HCV-infected remain undiagnosed [104]. The prevalence of CHB among patients with CHC is approximately 2–10% [105].

In Europe, HCVAb prevalence among the general population was estimated at 1.4% and at 1.1% within the EU/EEA [39, 41, 109]. A modelling study estimated the prevalence of viremic CHC at 0.64% in EU/EEA in 2015 [122].

Notification rate of HCV was 7.4 per 100,000 with male-to-female ratio 1.9:1 and 51.6% of cases notified among the 25–34 year olds in EU/EEA in 2016 [123]. The highest HCVAb seroprevalence rates in EU/EEA countries have been observed among incarcerated persons (4.3–86.3%), PWID (13.8–84.3%) and MSM (0–4.7%) [113].

Migrants from HCV-endemic countries (HCVAb≥1%) were estimated to account for 14% of the total CHC burden in EU/EEA [39, 92]. Nearly 80% of migrants in EU/EEA have arrived from HCV-endemic countries and approximately 30,400 migrants with CHC entered the EU/EEA in 2015 [39, 122]. HCVAb seroprevalence among migrants in Europe ranges between 0 to 23.4% [41, 114]. In EU/EEA, HCVAb prevalence among migrants from endemic countries was estimated at 2.3% with 1.6% of the migrants being viremic [39].

Hepatitis C prevalence among the general population in Finland was estimated at 0.3% in 2013 based on surveillance data. Of all notified HCV cases in Finland during 1995–2013, 11.7% were born abroad. [124] A systematic review and meta-analysis predicted an HCVAb prevalence in Finland of 0.68% and a modelling study estimated a prevalence of viremic CHC in Finland of 0.4% in 2015 [119, 122]. HCVAb seroprevalence was 0.64% among pregnant women attending ANS in 2010 [124]. In 2017, hepatitis C notification incidence was 20 per 100,000, the majority of infections were in age group 20–24 year olds, 65% of infections were observed among men and 16% had foreign origin [5]. A meta-analysis predicted the CHC prevalence among migrant populations from HCV-endemic countries (HCVAb ≥1%) in Finland to be at 1.9% [39].

2.3.3 EPIDEMIOLOGY OF HIV

Global age-standardized HIV prevalence was 0.40% in 2013 [125]. In 2017, 36.9 million persons were living with HIV, approximately 1.8 million persons were newly infected and 0.9 million died of HIV/AIDS-related conditions with tuberculosis (TB) being the leading single cause of death [126, 127]. Global HIV incidence has decreased since 1997 and mortality since 2005 mainly due to rapidly improving ART coverage [126]. Globally, HIV infections are mainly diagnosed among young adults and occur equally among both sexes [125]. Worldwide HIV prevalence is increasing due to improved prognosis achieved with ART [72]. In 2017, 75% of people living with HIV (PLWH) were aware of their status and 59% had access to ART [127]. Globally, the populations most vulnerable to HIV include sex workers, MSM, incarcerated persons, PWID and transgender women [128-131].

Countries with HIV prevalence over 1% among the general adult population are defined as having generalized epidemics. Prevalence over 5% in any population sub-group is defined as a concentrated epidemic. Countries with general population prevalence less than 1% and without any concentrated epidemics are categorized as having mixed HIV epidemics. [132]

The highest HIV prevalence has been observed in SSA (1.33–11.85%), the Caribbean and Latin America (0.11-0.50%), Eastern Europe (0.2%) and Asia (0.03–0.2%) [125]. At the same time, the burden of HIV is highest in SSA and Asia and the Pacific with 25.7 million and 5.2 million PLWH, respectively, and 0.66 million and 0.17 million deaths in 2017, respectively [133].

In Europe, overall HIV prevalence was 0.16–0.34% in 2016 with 1.3–2.7 million PLWH [98, 134]. According to UNAIDS estimates, adult prevalence of HIV in Eastern Europe and Central Asia was 0.8% in 2017 [135]. In WHO European region, 160,000 people were diagnosed with HIV in 2016 of whom 80% were notified outside the EU/EEA. The majority of cases were in the 30–39 year age group and male-to-female ratio was 2.3:1. [136]

Heterosexual transmission was the most common mode of transmission in Eastern Europe while the majority of transmissions in Central and Western Europe occurred among MSM. In Eastern Europe, the notification incidence of HIV has nearly doubled during the last decade and the highest rate in 2016 was observed in Russia. [136] The HIV epidemic in Eastern Europe and Central Asia is largely driven by IDU and their bridging populations, limited harm-reduction services, suboptimal ART coverage and criminalization and stigmatization of MSM [137]. On average 83% of PLWH in EU/EEA have been diagnosed and the rest are unaware of their infection [138].

Migrants represented 38% of notified HIV infections in EU/EEA during 2007–2012 and the majority were from SSA (53%). During 2007–2012, the number of annual HIV notifications among migrants decreased by 14%, largely reflecting a decrease in HIV notifications among migrant women from SSA. [139] Estimates of HIV prevalence among general migrant populations in Europe range between 0 and 14.0% depending on the reporting country and migrant population [140-142].

In comparison to native populations, migrants with newly diagnosed HIV in EU/EEA were younger and more commonly women. Heterosexual transmission was the most common transmission category among migrants from Africa, Eastern Europe, South Asia, and the Caribbean, whereas MSM transmission was more common among migrants from the Americas, Central and Western Europe, East Asia and the Pacific and Oceania. [139] Among heterosexual and perinatally acquired HIV transmissions, the majority of infections occurred among migrants (58 and 57%, respectively) [4, 42]. Migrants from endemic countries are considered the population most vulnerable to MTCT of HIV in EU/EEA [115].

In Finland, approximately 170 new HIV infections are reported annually. In 2018, HIV notification incidence was 2.8 per 100,000, the majority of infections were diagnosed among 35–39 year olds, 68% of cases were male and 59% had foreign origin. Heterosexual transmission represented 36% and MSM transmission 26% of cases. [143] According to national estimates, there were approximately 3,800 PLWH in Finland in 2017 [144, 145]. No seroprevalence assessments among the general population have been performed but the seroprevalence of HIVAgAb among pregnant women was

0.027% during 2005–2009 [88]. Of the pregnant women with HIV in Finland, the proportion of migrants increased from 18 to 75% from 1999 to 2013 [146]. HIV prevalence among pregnant migrant women in irregular situations in Helsinki during 2014–2018 was 5% [117].

2.3.4 EPIDEMIOLOGY OF SYPHILIS

The global prevalence of active syphilis defined as having both treponemal and non-treponemal test positivity was estimated at 0.5% in 2012 with nearly 18 million infected individuals and 5.6 million incident adult cases annually [147]. According to Global Burden of Disease study estimates, global syphilis prevalence was higher among men (0.6%) as compared to women (0.4%) [98]. Although the global burden of syphilis has decreased during the last decades, there were still approximately 137,000 deaths due to neonatal syphilis in 2013 [99, 147, 148].

Low-income countries have the highest prevalence rates and the burden of syphilis is highest in Africa with 1.8% of the population infected [147]. Globally, female sex workers and MSM bear a substantial burden of syphilis and have been recognized as key populations for syphilis prevention [149].

Syphilis prevalence among migrants has been reported at 0.4–6.0% with highest seroprevalence rates among migrants from SSA, East Asia and the Middle East and North Africa [114, 150, 151].

In EU/EEA, syphilis notification incidence was 6.1 per 100,000 in 2016 and has been on the rise since 2010. Male-to-female ratio of reported infections was 7.9:1 in 2016 and has steadily increased since 2000. Since 2007, notifications among older age groups have continuously increased with one-third of infections in 2007–2016 notified among persons 45 years or older. The proportion of MSM transmissions among all transmission categories has increased since 2010 and was 66% in 2016. Every third incident syphilis case, and 41% of the cases among MSM with known HIV status had HIV coinfection. [152] Approximately 8.5% of the syphilis cases in EU/EEA since 2000 have been reported among migrants. Heterosexual mode of syphilis transmission was more common among migrants in comparison to natives in the EU/EEA (57 vs. 35% respectively). [4]

In Finland, notification incidence of primary and latent syphilis was 3.4 per 100,000 in 2018. The majority of infections in 2018 were diagnosed among 30–35 year olds, males represented 79% of the notified cases and 49% had foreign origin. [153] A syphilis outbreak was observed in Finland in 1995 after the dissolution of the Soviet Union and increased travel to Russia. Majority of the infected had Finnish origin (83%) and half of the infections occurred outside of Finland. [154] In recent years, the majority of infections among native Finns have occurred in Finland [5]. TrpaAb seroprevalence was 0.11% among pregnant women attending antenatal follow-up in Finland during 2005–2009 [88]. One syphilis case was identified among 60 pregnant

migrant women in irregular situations in Helsinki, Finland, during 2014–2018 [117].

2.4 PERSPECTIVES ON HEPATITIS B AND C, HIV AND SYPHILIS AMONG MIGRANTS

Based on current evidence on epidemiology of hepatitis B and C, HIV and syphilis among migrants, three recurrent themes seem to emerge:

- Infectious disease prevalence among migrants mirrors the general population prevalence in countries of origin
- Healthy migrant phenomenon: infectious disease prevalence among migrants is lower than among the general population in countries of origin or of current residence
- Migrants are vulnerable to infections post-migration in the current countries of residence

2.4.1 MIRRORED EPIDEMIOLOGY IN THE COUNTRIES OF ORIGIN

Evidence suggests that the epidemiology of hepatitis B and C, HIV and syphilis among migrants mirrors that of countries of origin and that the risk factors for infection among migrants in current country of residence (CCOR) and general population in countries of origin are similar [139]. Mirroring has been reported with respect to seroprevalence rates, pathogen genotype distribution and transmission categories [37, 106, 139, 155-157].

In a systematic review and a meta-analysis, CHB prevalence was higher among migrants from high-prevalence regions, that is East Asia and the Pacific (11.3%) and SSA (10.3%), and lower among migrants from low-prevalence regions such as Latin America and the Caribbean (1.7%) [106]. Another review identified highest HBsAg seroprevalence rates among refugees and asylum seekers from high-prevalence areas (SSA and Asia) [150]. A large cross-sectional study among 95,000 asylum seekers in Germany concluded that observed HBsAg and HIVAgAb seroprevalences mirror the prevalences in the countries of origin [158].

A Danish register-based cohort study found highest risk for HIV among migrants from SSA followed by Latin America and the Caribbean, Southeast Asia and Eastern Europe and Central Asia [159]. Female refugees and asylum seekers from Africa had higher odds of testing positive for HIV among all refugees and asylum seekers to the UK in 2013–2017, exemplifying the burden of HIV among women in Africa [126, 160]. Although overall immigration from Africa to Europe has increased during the 21st century, the number of notified HIV cases among migrants from SSA in EU/EEA has decreased during 2007–2012 [3, 139]. The phenomenon may reflect the increasing ART coverage in SSA [139].

Furthermore, transmission mechanisms of HIV among migrants from SSA mimic epidemics in the countries of origin [139]. In contrast, MSM transmissions are overrepresented among Latin American migrants in EU/EEA in comparison to those reported in the countries of origin suggesting a possible selective migration of MSM from these areas [139, 161].

HBV, HCV and HIV viral strains among migrants in Europe are similar to those in the countries of origin [37, 155-157].

2.4.2 HEALTHY MIGRANT PHENOMENON

Healthy migrant phenomenon refers to the observation that migrants might have better health outcomes in comparison to general populations in the countries of origin or to that of the CCOR. The phenomenon is due to selective migration of healthier individuals or distribution of better health characteristics among the migrant populations than among the permanent residents in the CCORs. [6]

In Finland, two register-based cohort studies have found that migrants had a significantly lower mortality risk in comparison to Finnish-born persons [162, 163]. The mortality benefit was especially pronounced among men from Middle East and North Africa, SSA and Asia, and among women from FSU, Middle East and North Africa, and Asia, and among migrants with low income [162, 163]. Mortality was lower for all causes of death although no separate analyses were performed for infectious diseases [162]. Migrants' mortality benefit might also be due to the so-called "salmon bias" that results from selective return migration of older persons or individuals with terminal illnesses resulting in mortality underreporting in the death statistics of the CCORs [162, 164].

Several observations from infectious disease seroprevalence surveys among migrants suggest a lower seroprevalence in comparison to general populations in countries of origin. A recent literature review found nine of 14 studies reporting lower HBsAg prevalence among migrants in EU/EEA than general population estimates in countries of origin [40]. Lower HBsAg seroprevalence rates were also observed among refugees and asylum seekers to the UK during 2013–2017 in comparison to in-country rates [160]. In contrast, another review showed no difference in the HBsAg seroprevalence between in-country general population and migrants in the USA [107].

Evidence supporting the healthy migrant phenomenon regarding CHC is not as clear. A review on HCVAb prevalence among migrants in EU/EEA found three out of 12 studies showing lower HCVAb seroprevalence among migrants in EU/EEA in comparison to seroprevalence estimates among general population in countries of origin, and in seven studies the HCVAb seroprevalence was comparable to that in the countries of origin [39]. A later cross-sectional study among refugees to the UK found substantial variation among the CHC prevalence rates in comparison to in-country estimates [160].

For HIV, a large collaboration cohort study demonstrated lower mortality among migrant PLWH in Europe, Canada and USA in comparison to native PLWH. Differences in mortality patterns among migrant and native PLWH were explained by differences in non-AIDS mortality but the authors recognise healthy migrant phenomenon and salmon bias as possible contributing factors. [165] Similarly, a European cohort study demonstrated lower or comparable mortality among heterosexual migrant men living with HIV in comparison to native men. However, higher mortality was observed among heterosexual migrant men from Latin America and women from the Caribbean. [166]

A recent large British cross-sectional pre-migration prevalence study identified generally higher HIV prevalence rates among refugees and asylum seekers as compared to in-country prevalence rates. Syphilis seroprevalence among the same study population, on the other hand, was mostly lower than among general populations in the countries of origin. [160]

Among the major migrant populations in Finland, recent reviews on in-country and migrant population HBsAg seroprevalence rates do not clearly support the healthy migrant phenomenon (Table 1). Ott et al. estimated an HBsAg seroprevalence of 4.62% in Russia, which is significantly higher than the estimate of 2.89% among Russian-origin migrants provided by Kowdley et al. [102, 107]. There is substantial variation in HBsAg seroprevalence rates between countries of FSU: in some countries the in-country HBsAg seroprevalence seems to be significantly lower (Armenia, Azerbaijan, Estonia and Ukraine) and in others higher (Kyrgyzstan, Moldova, Turkmenistan) than among FSU-origin migrants [40, 96, 97, 102, 107]. Conversely, Kowdley et al.'s estimate of 3.10% HBsAg seroprevalence among migrants from Iran is significantly higher than the in-country estimates provided by other researchers [96, 97, 102, 107].

2.4.3 MIGRANT-SPECIFIC VULNERABILITIES TO HEPATITIS B AND C, HIV AND SYPHILIS

2.4.3.1 Vulnerable migrant populations

Some migrants might be especially vulnerable to hazardous health outcomes including infectious diseases. Factors associating with increased vulnerability may derive from genetic, biological, environmental, behavioural or socio-demographic determinants for health and disease. [6] Populations in vulnerable situations generally include children, elderly, disabled persons, sexual minorities, detainees, forced migrants, victims of exploitation and migrants in irregular situations [167]. Some migrants might have several, overlapping vulnerabilities to infection [141]. Here, vulnerabilities to infection during transit and after arrival are discussed. Of note, however, is that they might occur at any point of the migration cycle (Figure 1).

Table 1. *Systematic reviews or modelling studies estimating HBsAg and HCVAb seroprevalence in Russia, other Former Soviet Union countries, Iran, Iraq, and Somalia (in-country estimates) and among migrants from these countries; % [95% CI].*

	HBsAg					HCVAb	
	In-country			Migrants		In-country	Migrants
	Schweitzer 2015[96]	Ott 2017[102]	Polaris Observatory Collaborators 2018[97]	Kowdley 2012[107]	Ahmad 2018[40]	Gower 2014[119]	Falla 2018[39]
Russia	2.73 [2.64–2.83]	4.62 [4.22–5.07]	1.4 [0.6–1.7]	2.89 [2.16–3.62]	NA	4.1 [1.2–5.6]	NA
Former Soviet Union countries[a]	From 1.45 [1.10–1.89] in Ukraine to 10.32 [8·56–12.38] in Kyrgyzstan	NA	From 0.5 [0.5–0.6] in Estonia to 9.5 [8·7–11.4] in Turkmenistan	3.83 [2.74–4.91]	4.7 [3.3.–6.6]	From 1.3 [0.9–2.9] in Belarus to 11.3 [6.4–13.1] in Uzbekistan	3.1 [0.4–10.7]
Iran	0.96 [0.95–0.96]	1.11 [1.11–1.12]	1.7 [1.6–1.9]	3.10 [2.69–3.50]	0.7 [0.1–2.5]	0.5 [0.2–1.0]	0.7 [0–3.6]
Iraq	0.67 [0.65–0.70]	NA	3.5 [3.2–3.9]	1.31 [0–2.87]	0.7 [0–3.6]	3.2 [0.3–3.2]	0.3 [0–1.9]
Somalia	14.77 [13.77–15.84]	NA	NA	12.40 [8.89–15.92]	7.3 [4.6–10.7]	NA	NA

NA=Not available; [a]Other than Russia. Categories of hepatitis B endemicity: green=very low (<0.5%), yellow=low (<2%), orange=low-intermediate (2–4.99%), red=high-intermediate (5–7.99%), purple=high (≥8%) [55, 92]. Categories of hepatitis C endemicity: green=very low (<1%), yellow=low (1–2%), orange=intermediate (2–3%), red=high (3–5%), purple=very high (>5%) [120].

2.4.3.1.1 Labour migrants

A systematic review identified multilevel determinants for the HIV risk among labour migrants and circular workers. Frequency of seasonal work, longer residency away from the family, migration from rural to urban environment as well as alcohol and drug use were associated with increased risk for HIV, other STIs and risky sexual behaviours. [168] Seasonal workers and circular migrants also experience difficulties in continuity of healthcare and have a higher risk for treatment interruptions [169]. Epidemiology of hepatitis B and C, HIV and syphilis has not been previously studied among labour migrants in Finland.

2.4.3.1.2 Migrant women

Globally, women represent more than half of the PLWH and have higher HIV-related mortality in younger age groups despite having higher ART coverage in comparison to men [126, 170]. Women's vulnerabilities to infection relate to biological, behavioural and socio-demographic factors [170].

Migrant women in high-income counties are disproportionately affected by HIV due to factors such as sexual exploitation and difficulties in negotiating condom use [142]. In EU/EEA, women represented 63% of HIV cases among migrants in 2007–2012, whereas the majority of infections among the general population are observed among men [136, 139]. Women represented 80% of HIV cases among refugees and asylum seekers to the UK in 2013–2017 [160].

In a large European cohort study, 80% of HIV-infected pregnant women with a singleton live-birth delivery in 2002–2012 had migrant origin. Migrant women were more likely to be diagnosed with HIV during antenatal follow-up and with lower CD4 cell levels in comparison to native women, and had also a higher risk for HIV diagnosis late in pregnancy. [171] Similar observations have been made in Finland, where migrant mothers with HIV were diagnosed more often in late pregnancy and with a later stage of disease in comparison to Finnish-origin mothers with HIV [146]. An earlier literature review of the ECDC identified several studies on migrant and ethnic minority mothers having higher proportion of HIV diagnosis in pregnancy in comparison to native mothers [172]. Delayed diagnosis in pregnancy among migrants might be explained by delayed entering to antenatal care observed in France, Germany and the Netherlands [173, 174].

A Dutch register-based study among pregnant asylum seekers from SSA found higher HIV prevalence among single women and unaccompanied minors. The results also suggested a higher prevalence of HIV among asylum seekers as compared to general-population pregnant women in the countries of origin. [175]

Pregnant migrant women in irregular situations in Denmark had significantly higher HBsAg seroprevalence and a borderline higher HIV prevalence in comparison to documented migrants [176]. Twelve percent of

pregnant migrant women in irregular situations in Helsinki, Finland, were diagnosed with hepatitis B, HIV or syphilis before delivery [117].

2.4.3.1.3 Forced migrants

Refugees and asylum seekers might be especially vulnerable to infections due to risk factors related to forced displacement and unselective migration. A systematic review and meta-analysis found that refugees and asylum seekers had 42% higher odds of being chronically infected with HBV in comparison to other migrants (9.6% and 5.1% respectively) [106]. A Danish register-based cohort study found a higher risk for HIV among refugees, family-reunified migrants and asylum seekers in comparison to Danish-born controls [159].

In contrast, no difference in HCVAb seroprevalence between refugees and other migrants has been observed [120]. A recent review also found no differences in HBV, HCV and HIV prevalence by migration status but underlined that many studies lack information necessary for the differentiation of the reason for immigration [150].

In 2016, approximately 40.6 million persons globally were victims of forced labour or marriage. Almost five million individuals were involved in forced sexual exploitation and 14% of them resided within Europe and Central Asia. [177] Human exploitation and trafficking might predispose migrants to blood-borne and sexually transmitted infections due to overcrowded and unhygienic travel and living conditions and sexual abuse [178]. Epidemiology of hepatitis B and C, HIV and syphilis among forced migrants in Finland has not been previously studied.

2.4.3.1.4 Migrant MSM

Migrant MSM are especially vulnerable to HIV due to racism, economic deprivation, sex work, substance use, high-risk sexual activity and limited access to services [179]. Discrimination and stigmatisation of MSM in countries of origin might serve as a push factor for migration [139]. During 2007–2016, the proportion of MSM transmission among HIV diagnoses notified among migrants in EU/EEA increased from 24% to 30% [136, 139, 180]. In Finland, 59% of the MSM transmissions of HIV in 2018 were reported among migrants [143].

During 2000–2010, fewer MSM transmissions of syphilis were reported among migrants (43%) than among natives (65%) in the EU/EEA [4]. A marked increase in MSM transmission of syphilis has been observed in the EU/EEA in 2010–2016 but the proportion of migrants among these MSM transmissions has not been evaluated [152]. Epidemiology of hepatitis B and C and syphilis among migrant MSM in Finland has not been described.

2.4.3.1.5 Sex workers

Sex workers are disproportionately affected by HIV globally and in EU/EEA [129, 181]. Increasing proportions of migrants are working in the sex and erotic industry in Europe [182]. Migrant sex workers are especially vulnerable to STIs due to lower socio-demographic determinants for health, exploitation,

irregular migration status, poor language skills and limited access to STI prevention services [182-185]. However, in a British cross-sectional survey among female sex workers, migrant origin was not associated with higher prevalence of STIs although migrants reported higher rates of sexual risk behaviour and less service use in comparison to natives [182].

Male sex workers are considered a hidden key population for STI control in many countries of Europe [183, 186]. A cross-sectional study from the Netherlands showed that male sex workers had significantly higher risk for undiagnosed hepatitis B, HIV or syphilis in comparison to female sex workers. Although the majority of male sex workers in this study had migrant origin, migrant origin was not associated with new diagnoses of STIs. [186]

In a Finnish cross-sectional survey among sex workers in 2012–2013, two thirds of study participants had been born outside of Finland with Russia, Estonia and Thailand being the most common countries of origin. Migrant sex workers had significantly lower coverage of hepatitis A and B vaccinations and STI testing within the past 12 months in comparison to Finnish origin participants. HIV prevalence was 3% and HCV-Ab seroprevalence 5% without significant differences by origin. [187]

2.4.3.1.6 Injecting drug users

Globally, approximately 9.0% of PWID are HBsAg-positive, 52.3% are HCVAb-positive and 17.8% have HIV. Concurrency of risk factors is common among PWID: a systematic review found that 59.7% had a history of incarceration, 16.8% recent commercial sex work and 37.4% reported recent unprotected sex with a non-regular partner. [188]

During 2007–2012, IDU-associated HIV infections among migrants in EUE/EEA represented less than 10% with the exception of migrants from Eastern Europe among whom IDU accounted for 25% of new the HIV infections [139]. Among forced migrants in high-income countries, substance use prevalence rates of less than 5% have been observed. However, camp settings especially might increase risky behaviour. [189]

In another analysis based on the population-based Migrant Health and Wellbeing Survey in Finland (Maamu), prevalence of substance use among Kurdish, Russian and Somali migrants was rare and migrants reported significantly less alcohol use compared to the general population. Immigration as a minor and longer duration of residency in Finland increased the odds of lifetime cannabis use. [190]

2.4.3.1.7 Prisoners

Prisoners and incarcerated persons are at risk for sexually transmitted and blood-borne infectious diseases due to criminalization and detention of PWID, continued drug injection and other risk behaviours in prisons in the absence of drug dependency treatments and harm reduction programmes. Globally, 4.8% of incarcerated persons in 2013 had CHB, 15.1% had CHC and

3.8% were living with HIV. The burden of infections was especially high in areas with generalized HIV epidemics or high prevalence of IDU. [191]

At the end of 2015, 15.1% of incarcerated persons in EU/EEA were foreigners [192]. Incarcerated migrants from high-prevalence countries might contribute to the epidemics of blood-borne infections among prisoners in EU/EEA [113]. Epidemiology of hepatitis B and C, HIV and syphilis among prisoners of foreign origin in Finland has not been assessed.

2.4.3.2 Entitlement, access and retention in health services

Migrants face specific barriers in entitlements, access and retention in care that hinder the achievement of optimal treatment cascades from testing to diagnosis to quality of care of blood-borne and sexually transmitted infections. Whereas entitlement to care refers to the existing legal frameworks of organizing healthcare for individuals without national health insurance, access to care is influenced by various other determinants at individual, healthcare provider and societal levels (Table 2). A recent systematic review summarised individual-level barriers and facilitators influencing acceptability and accessibility of infectious disease interventions among migrants [193].

Depending on immigration status, some migrant groups might lack health insurance and have restricted entitlements to public health services in EU/EEA [167]. In a survey among specialists from six European countries, restricted entitlements to hepatitis B or C treatment were reported for migrants in irregular situations, for asylum seekers and for persons without health insurance [194]. Migrants in irregular situations were not entitled to ART for HIV in 14 of 31 EU/EEA member states in 2016 [195, 196].

In Finland, migrants living permanently in the country can be registered in the municipality of residence and granted entitlements to municipal healthcare services and national health insurance [197]. Municipalities are responsible for organising the infectious diseases control and providing of care in their area [198]. Adult asylum seekers' entitlement to care is restricted to necessary care whereas asylum-seeking children have no restrictions in entitlements to care in comparison to permanent residents [199]. For migrants in irregular situations, entitlement to care is restricted to urgent situations [200]. HIV care during pregnancy and treatment of generally hazardous infectious diseases are considered urgent care [201]. Migrants in irregular situations pay the costs of healthcare out of pocket [202]. Some municipalities are providing broader healthcare services for irregular migrants and subsidizing the treatment costs [203].

Restricting entitlements to care has implications on health, healthcare systems and epidemiology of blood-borne and sexually transmitted infections [195]. Restricted entitlements to care, such as ART for HIV, have been associated with increased healthcare costs [167, 204, 205]. A systematic

review concluded that restrictions in entitlements to hepatitis B care are likely to contribute to increasing infection burden in low-prevalence settings [96].

Table 2. *Migrant-specific barriers for access to healthcare services for hepatitis B and C, HIV and syphilis in high-income countries* [34, 142, 167, 169, 174, 193, 195, 196, 206-212].

	Availability	**Accessibility**	**Acceptability**
Institution	• Restricted entitlements to care due to immigration status • Regulatory barriers in testing and care	• Social and economic deprivation • Restricted entitlement to health insurance • Administrative barriers	• Policy-level discrimination
Healthcare provider	• Lack of community-based services • Lack of qualified staff • Lack of interpretation services	• Low level of provider-initiated testing • Lack of information materials • Poor referral pathways • Complicated access to services	• Lack of culturally competent services • Poor pre-test counselling • Discrimination among health professionals
Individual	• Stigma, fear of disease, fear of disclosure and discrimination • Fear of impact on immigration process • Differences in health seeking behaviour • Availability of condoms	• Low acculturation • Poor health literacy • Poverty and healthcare costs • Poor language skills • Low perceived risk	• Fear of breaking patient confidentiality

Broadening entitlements to care does not seem to act as a pull factor for immigration. In Sweden, adoption of regulation on care to irregular migrants in 2013 did not result in increased immigration rates. Implications for the treatment of infectious diseases were not evaluated. [213] In Finland, impact of broadening entitlements to services at municipal level on the service use or costs has not been evaluated.

An implementation gap between existing entitlements to care and use of services has been observed among irregular migrants in EU/EEA. Migrants with restricted entitlements to care tend to use services less than they are

entitled to, exemplifying other types of informal barriers in accessing care. [174, 211, 214]

Access to care of hepatitis B and C, HIV and syphilis among migrants is illustrated by testing and treatment rates as well as proportion of late diagnoses [138]. HIV testing rates among migrants from high-prevalence countries was 4–62% in EU/EEA with only a minority of countries reporting testing rates [215]. In France, HIV testing among migrants was positively associated with lacking residency permit or unemployment suggesting that marginalized populations are offered testing more actively [216].

Late diagnosis is a symptom of barriers to screening. Migrants in EU/EEA and other high-income regions have a higher risk for late HIV diagnosis as compared to natives [34, 139, 159, 217, 218]. Late HIV presentation was associated with SSA and Southeast Asian origin in a register-based cohort in Denmark, and the risk remained elevated during the first year after arrival for refugees and up to 10 years after arrival for family-reunified migrants [159]. In Finland, foreign nationality was associated with late HIV diagnosis and delayed access to care among cases notified in 1985–2005 [219].

Migrant origin has also been associated with poorer retention in care as compared to non-migrants. A large pan-European cohort study among PLWH found that migrant men especially had lower probability of ART initiation than native men [220]. A lower proportion of migrants living with HIV in EU/EEA are virally suppressed in comparison to natives [46]. Migrant PLWH in high-income countries have also a high risk for missing appointments and are lost-to-follow-up [34].

A review concluded that migrants in Europe have lower CHB treatment initiation rates compared to residents, and findings were confirmed in a later cross-sectional study [221, 222]. In Finland, access to HCV testing, counselling and treatment varies considerably in different municipalities regardless of residency status [223].

2.4.3.3 Post-migration acquisition of infections

Although infectious disease endemicity and suboptimal healthcare coverage including preventive services in countries of origin make an important contribution to migrants' risk for infection, transmission might also take place post-migration either in countries of origin, transit or destination (Table 3). Implementation of preventive measures post-migration thus has the potential to prevent new infections of hepatitis B and C, HIV and syphilis and decrease the disease burden among migrants.

Risk for post-migration infection of HIV in high-income countries has been associated with Latin American or Caribbean origin, IDU, MSM, young age, male sex and longer duration of residency in CCOR. Stigma, risk behaviours and limited access to services, among other factors, have been identified as reasons behind the increased risk. [34]

Table 3. *Risk factors for transmission infectious diseases according to location and timing pre- or post-migration* [95, 168, 169, 210, 224-226].

	Country of origin	Country of residence
Pre-migration transmission	Transmission before migration in a country of origin or transit • Higher prevalence of infections • Disrupted health systems and poor health coverage, including prevention and continuum of care	Transmission before migration in the current country of residence • Poor health coverage among temporary migrants • Circular migration, seasonal employment • Poor health literacy
Post-migration transmission	Transmission post-migration in country of origin or transit • Higher prevalence of infections • Visiting friends and relatives • Travel-associated risk behaviours • Healthcare use during travel and iatrogenic transmission	Transmission post-migration in the current country of residence • Poor health coverage among resident migrants • Perceived lower risk and risk behaviours • Assortative social and sexual mixing • Poor health literacy

2.4.3.3.1 Post-migration acquisition rates

An increasing body of evidence suggests that a large proportion of HIV infections among migrants occur post-migration, particularly in CCORs. Systematic review of studies published in 2002–2014 found 2–62% post-migration acquisition rates of HIV in Europe depending on the country and migrant population. Post-migration transmission appeared most common among MSM transmissions. [95] In a recent pan-European cross-sectional survey among migrants living with HIV, 44.3–66.1% of the respondents reported a previous HIV negative test in the CCOR, with highest rates among MSM [209].

A number of studies have predicted the likely date of transmission based on phylogenetic analyses or mathematical trajectory models [227]. A multicentre cohort study of migrants living with HIV from nine European countries estimated an overall post-migration acquisition rate of 63% by combining self-reported background information with information on CD4-cell counts and HIV-RNA-level measurements [227, 228]. Proportion of HIV infections acquired post-migration was higher among MSM (72%) and PWID (75%) than among heterosexual men (58%) and women (51%). Migrants from SSA had lower post-migration acquisition rates than migrants from other regions. Post-migration infection with HIV was associated with longer time of residency and with recent diagnosis. [228]

A modelling study from France based solely on CD4 T-cell count at diagnosis estimated the rate of post-migration HIV infections among

migrants from SSA to be 35–49%. Risk of post-migration infections was associated with younger age at immigration and longer residency. [229]

Post-migration acquisition rates of HIV in Sweden based on a CD4 T-cell decline trajectory model were significantly higher (19%) than physicians' estimates (12%). Discrepancies between physicians' estimates and modelled transmission dates were associated with older patient age, higher CD4 levels, longer residency at diagnosis, and heterosexual transmission. [230] The rate of post-migration acquisition of HIV has not been evaluated among migrants in Finland.

Less is known about possible post-migration acquisition of other sexually transmitted and blood-borne diseases. According to a systematic review and a meta-analysis, more than half of international migrants lack prior natural or induced immunity to hepatitis B [106]. A register-based study from England and Wales indicated that the majority of South Asian migrants infected with acute hepatitis B had no travel history and had acquired the infection post-migration [231].

A phylogenetic analysis of HBV strains among Malian asylum seekers in Italy found that 12.5% of asylum seekers had been infected post-migration [155]. However, another study from Italy estimated the date of HBV infection based on phylogenetic analyses of the viral strains and compared it to the date of immigration, and concluded that the majority of HBV infections among migrants from endemic countries were acquired before immigration in countries of origin [232]. Supporting the assumption that the majority of the hepatitis B and C infections among migrants are transmitted before migration, first-generation migrants in EU/EEA have higher HBsAg and HCVAb prevalence than second-generation migrants [92, 157].

2.4.3.3.2 Sexual mixing

Patterns of choosing sexual partners of similar (assortative) or different (disassortative) characteristics – such as origin and ethnicity – can influence the prevalence of infectious diseases within the sexual networks and subsequent risk of transmission [95, 148]. Sexual mixing patterns could thus explain differences in epidemiological patterns between countries and populations [148]. Phylogenetics and molecular epidemiology can be used to analyse the transmission networks and their dynamics [233].

A systematic review on evidence of sexual mixing among migrants as a driver for post-migration HIV infections in Europe was inconclusive. Assortative sexual mixing was supported by the occurrence of non-B-HIV subtypes mainly among people born outside Europe and clustering of new infections by ethnicity. On the other hand, disassortative sexual mixing was supported by the increasing incidence of non-B-HIV clades among non-migrants and ethnic minorities. Surveys among migrants support both assortative and disassortative sexual mixing. [95]

A more recent analysis of the distribution of HIV-1 sub-types in Europe identified introduction of non-B-subtypes of HIV-1-related to migration and

later mixed occurrence of B and non-B sub-types both in migrant and native populations, suggesting linked epidemics and disassortative sexual mixing [37].

Moreover, assortative sexual mixing among migrants was supported by findings from a pan-European collaboration study on phylogenetic clustering of HIV strains that found non-B strains to be present less frequently in phylogenetic clusters [234].

2.4.3.3.3 Travel to visit friends and relatives

Return travelling to countries of origin, or so-called visiting friends and relatives (VFR) tourism, is common among migrants [225, 235, 236]. Travel-related infections of food and water-borne diseases, vaccine-preventable diseases including hepatitis B, TB and malaria have been described among VFRs and studies suggest that VFRs might carry a disproportionate burden of travel-related morbidity [235, 237, 238].

Longer duration of travel, travel destinations, accommodation with relatives, lower usage of travel health services prior to travel and increased risk behaviour might increase migrants' risks for travel-related infections [224, 225, 235-237]. Sexual partnerships during travel were also common especially among male VFRs [225].

Medical tourism occurs during VFR travels. Enhanced surveillance of hepatitis B in the UK during 1995–2000 showed that medical treatment during travel was the most common route of hepatitis B transmission among South-Asian origin migrants [231]. In another study based on the Maamu survey, 15.4% of the Russian-origin migrants in Finland had visited a physician in Russia during the last 12 months [226].

2.5 APPROACHES FOR PREVENTION

Approaches for prevention and early diagnosis of blood-borne and sexually transmitted infectious diseases among migrants are mainly based on primary or secondary prevention strategies (Table 4). Primary prevention aims at averting infection [239, 240]. Secondary prevention encompasses attempts to minimize disease-related morbidity by means of early diagnosis and effective treatment of those already infected. Tertiary prevention of infectious diseases encompasses approaches aimed at rehabilitation of the infected and prevention of recurrence of the disease. [239]

Primary and secondary approaches for infection prevention are intertwined as treating the infected can prevent further transmissions. Indeed, treatment of infected persons in order to reduce infectiveness and to prevent further transmissions has proven an attractive approach to halt epidemics of HCV and HIV [241]. Primary prevention of HIV by short-term usage of ART, so-called pre-exposure prophylaxis, has been shown to be effective and safe [242, 243]. Post-exposure prophylaxis should be offered to persons with a potential exposure to HIV transmission [79].

Table 4. *Approaches for primary and secondary prevention of hepatitis B and C, HIV and syphilis [12, 48, 239].*

Primary prevention	Secondary prevention
• Health literacy	• Screening
• Vaccinations	• Case finding
• Pre- and post-exposure prophylaxis	• Self or provider-initiated testing
• Treatment as prevention	• Low-threshold services
• Harm reduction	• Treatment
• Policies and strategies	

2.5.1 HEALTH LITERACY

Health literacy, defined as the cognitive and social skills which determine individuals' motivation and ability to access, understand and use information to promote health, is a key element of health promotion. Health literacy frameworks suggest opportunities to improve healthy behaviour by addressing health literacy gaps. [244] A recent systematic review concluded that both low knowledge and low risk-perception are likely to act as barriers to infectious disease prevention among migrants in the EU/EEA [193].

Several tools have been developed to measure health literacy [245, 246]. Following the United Nations General Assembly Special Session (UNGASS) Declaration of Commitment on HIV/AIDS in 2001, a specific set of indicators for monitoring the HIV-related knowledge, attitudes and practices (KAP) among young people was developed [247-249].

Studies on health literacy among migrants and displaced populations in Europe indicate gaps in literacy. A cross-sectional study in Sweden on comprehensive health literacy among recently-arrived refugees found that the majority had low levels of health literacy [250]. Sudanese immigrants in Denmark were more knowledgeable about HIV than Somali-origin migrants, and better knowledge was associated with male gender, older age and higher level of education [251]. In Spain, inadequate level of HIV KAP was associated with North African origin and unemployment [252]. Furthermore, HIV-related misconceptions were common among migrants in Cyprus, with better knowledge associated with male gender [253]. In a cross-sectional study among migrants in Germany, knowledge on transmission routes of hepatitis B and C was significantly associated with younger age and higher education [254]. A large European cross-sectional survey among migrants found that more than half of the respondents did not know where to access free condoms [207].

Few studies compare STI-related health literacy between migrants and natives. In Germany, FSU-origin adult migrants had lower level of HIV knowledge compared to natives [255]. Similarly in Italy, poor HIV knowledge was associated with migrant origin and lower level of education [256].

Heath literacy has been associated with healthy behaviours such as condom use or STI testing rates. In a cross-sectional survey among immigrant Thai women in Sweden, poor knowledge of sexual and reproductive health (SRH) services was found to associate with low levels of service use [257]. A systematic review found that knowledge, attitudes and behaviours related to HIV and healthcare services have been associated with HIV testing rates. Better knowledge and engaging in HIV-related risk behaviours seem to increase testing whereas low perceived risk for HIV decreases testing. [210] Additionally, limited knowledge might hamper the effectiveness of strategies to reduce the burden of CHB and CHC among the migrant communities, as demonstrated in two qualitative study among migrants and general practitioners in the UK [258, 259].

Several strategies have been adopted to improve HIV and STI-related health literacy among general populations [260, 261]. However, recent reviews show a lack of documented interventions targeted to migrant populations including migrant MSM [34, 262-264]. In the TRAIN HIV prevention programme, Tajik male labour migrants in transit to Russia demonstrated a significant increase in condom use in comparison to a control group [265]. A recent review concluded that HIV prevention and intervention programmes might increase HIV testing uptake among migrants but many of the included studies did not measure the impact of the interventions [264].

Effectiveness of STI prevention interventions are typically evaluated using indicators on sexual behaviour, such as condom use, rate of partner change and testing uptake as well as indicators on disease incidence and service use patterns [261]. Health literacy interventions are more efficient in improving knowledge but only limited evidence exists on the effectiveness, including cost-effectiveness, of such strategies on improved health behaviours and infectious disease incidence [261, 262, 266]. In fact, a Cochrane review from 2011 concluded that although population-based interventions on STIs seem to have a positive influence on condom use, there was no difference observed in HIV incidence [267].

Health information can be provided through various strategies and languages. A survey among clinicians involved in treatment of viral hepatitis in six European countries demonstrated a varying availability of interpreters and translated materials for linguistic minorities reflecting “difference-based” and “difference-blind” approaches of service delivery to migrants and ethnic minorities [268].

In Finland, municipalities have the primary responsibility of civic orientation and health promotion, and specific services are provided for migrants and refugees through a multidisciplinary approach [200, 269]. For children and adolescents, health education is delivered mainly programmatically in the curriculum and in school healthcare [270]. In practice, municipalities face challenges in reaching adult migrants through registry offices, municipal health and social services, immigrant service desks or school and student healthcare [271]. Many non-governmental organizations

(NGOs) deliver sexual and reproductive health education for the general population and some also focus on foreign-origin populations [145].

The impact of different health literacy initiatives among migrants has not been evaluated in Finland. National strategies and guidelines highlight that health education and services regarding sexual and reproductive health and infectious diseases should be delivered through channels that are accepted by and reach the at-risk populations [223, 270, 272].

2.5.2 SCREENING

Screening was defined by the Commission on Chronic Illness in 1951 as "the presumptive identification of unrecognized disease or defect by application of tests, examinations, or other procedures which can be applied rapidly" [240]. Wilson and Junger suggested ten principles for screening in 1968 that were amended by Andermann et al. in 2008 [240, 273]. In short, screening should produce sufficient public health benefits [274]. The number needed to screen, defined as the number of people that need to be screened to prevent one death or one adverse event, can be used to compare different screening strategies [275]. Screening tests are characterized by high sensitivity whereas high specificity is essential for confirmatory tests [73].

Screening is the key approach for early diagnosis of blood-borne and sexually transmitted infectious diseases especially among individuals without a history of risk behaviours [276]. These infections are often asymptomatic until a late stage of disease and hence only symptom-based testing can prolong the diagnosis. Screening of infectious diseases has a population health security aspect: early diagnosis limits the transmission of the disease to the population [277]. Screening of blood-borne and sexually transmitted infections can be organized through universal or selective screening, or opportunistic testing approaches. As screening of blood-borne and sexually transmitted infections is based on the application of tests, the term "testing" is often used as a synonym for screening [240].

Participation in screening can be mandatory or voluntary. In Finland, a voluntary opt-out strategy has been adopted for the majority of screening programmes [274]. In exceptional situations, Regional State Administrative Agencies have the right to implement mandatory health examinations and screenings of generally dangerous infectious diseases as defined in the Communicable Diseases Act [198].

Infectious disease screening effectiveness and cost-effectiveness are influenced by several factors along the screening trajectory (Figure 2). Loss-to-follow-up might occur at every phase of the screening and care cascade, which compromises the effectiveness and cost-effectiveness of screening. Additionally, effectiveness and cost-effectiveness of infectious disease screening is influenced by properties of the screening test, underlying prevalence of infectious disease in a population and costs of treatment. [208]

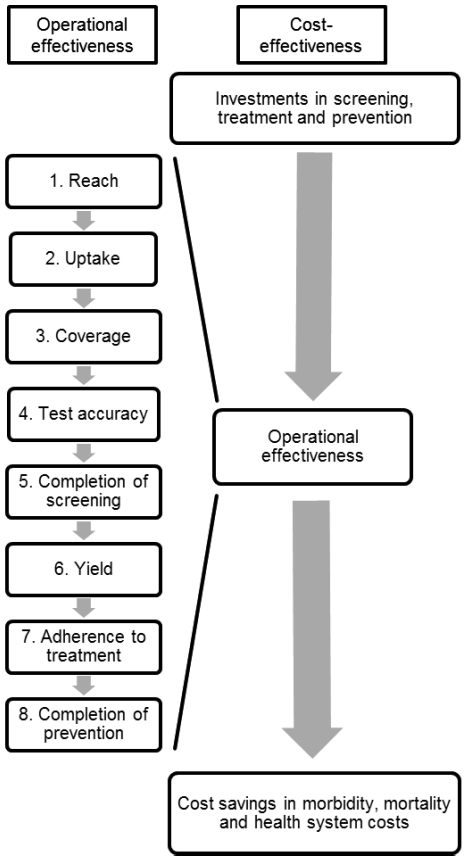

Figure 2 Operational effectiveness and cost-effectiveness cascade of infectious disease screening and care among migrants [36, 208, 278, 279].

2.5.2.1 Universal screening

Universal screening refers to large-scale screening of the whole population without a prior selection of specific risk groups or assessment of risk factors for infection [240, 279]. Universal strategy has several benefits: universal screening is usually better accepted both among patients and healthcare providers than screening focused only on risk groups, and it can identify infections among individuals with no known risk factors [280, 281].

ECDC recommends universal HIV screening in the contexts of STI clinics and PWID services, ANS, cases with clinical HIV indicator conditions and in settings where prevalence of undiagnosed HIV is known to be high [282]. Countries have adopted universal screening strategies for blood-borne and sexually transmitted infections in antenatal follow-up, prison settings, among high-prevalence birth cohorts or specific population groups such as asylum seekers [283-285].

ANS aims to prevent MTCT by early diagnosis and treatment of the mother and/or the child. ECDC recommends universal opt-out HIV and

syphilis screening in ANS settings [280]. The majority of EU/EEA countries have implemented ANS for CHB, HIV and syphilis, and some for rubella, with opt-out screening strategy being the most common approach [115]. The Finnish ANS programme includes voluntary universal opt-out multiphasic screening of hepatitis B (introduced in 1994), HIV (introduced in 1998) and syphilis (introduced in the 1950's) [88, 274, 286, 287]. Coverage of ANS in Finland is approximately 98% [88].

Several literature reviews have concluded that universal ANS of CHB, HIV and syphilis is effective and cost-effective [41, 279, 288, 289]. Multiphasic screening can further reduce the costs [290]. A Dutch study showed a modest cost-effectiveness for HCV screening of first-generation non-Western migrant populations in the ANS context [291]. Effectiveness of ANS among migrant women can be compromised due to migrant-specific barriers to care such as poor health literacy, mistrust, stigma and fear as well as language and cultural differences. Scientific evidence on feasibility of different approaches to increase the uptake of universal ANS among vulnerable populations is lacking. [280] An ECDC review identified a gap of evidence on approaches to increase effectiveness of ANS among migrant and ethnic minority women [172].

Blood donors in Finland are screened with universal strategy for hepatitis A (HAV-NAAT introduced in 2008), hepatitis B (HBsAg introduced in 1971), hepatitis C (HCVAb introduced in 1990, HCV-RNA in 2002), HIV (introduced in 1985) and human parvovirus B19 (HPVB19-NAAT introduced in 2001) [124, 292]. Finnish best practice guidelines recommend STI testing among women seeking an abortion [293].

2.5.2.2 Selective screening

Selective, or targeted screening, encompasses screening of specific populations, groups or individuals at increased risk for disease [240]. Selective infectious disease screening among migrants is implemented by the majority of high-income countries, especially among forced migrants, with strategies that differ between and even within countries [285, 294].

Consensus on pan-European guidelines for infectious diseases screening among migrants has been difficult to achieve and the ECDC has emphasized the role of national governments in giving context-specific guidelines [11, 36, 294, 295]. Recently has ECDC published an evidence-based guideline on screening of key infectious disease among migrants in EU/EEA. These guidelines recommend screening of HBV, HCV and HIV among recently arrived migrants originating from countries with HBV or HCV prevalence over 2%, and with HIV prevalence of over 1%. In addition, HIV screening is recommended for all migrants at increased risk for infection. HBV screening should encompass both screening of infection and immunity. [36]

Twenty two of 27 of EU/EEA countries recognize migrants as a population vulnerable to HIV, but a smaller number of countries (16/27)

recommend testing of migrants [296]. One-third of EU/EEA countries have screening policies for CHB and CHC for migrants from endemic countries [295].

Infectious disease screening programmes were implemented by 59% of EU/EEA Member States for newly arrived migrants, mainly asylum seekers and individuals from endemic areas, and majority had adopted a selective screening strategy [297]. While TB was the most common disease screened among migrants in the EU/EEA, screening for hepatitis B was implemented in 33%, hepatitis C in 27%, and HIV in 27% of countries. Screening was mandatory in 60% of the countries performing screening. [297] Among non-EU countries in Europe, screening of HBV was recommended in 3/18, HCV in 2/18, HIV in 7/18 and other STIs in 3/18 of countries [298].

All Nordic countries recommend screening of TB among refugees and asylum seekers, and all except for Denmark also recommend screening of hepatitis B and HIV. HCV screening of refugees and asylum seekers has been adopted by Norway and Sweden. [299]

The effectiveness of selective infectious disease screening among migrant populations in Europe was assessed in a recent systematic review with respect to several steps along the screening pathway (Figure 2). Results suggest that the operational effectiveness of infectious disease screening programmes could be improved. Although screening uptake was high, coverage was suboptimal and screening and treatment drop-out rates were substantial. Seedat et al. concluded that the evidence for cost-effectiveness of screening of hepatitis B and C, and HIV among migrants from endemic countries was moderate and strongly linked with operational effectiveness of the programme and treatment costs. [208] In Germany, costs of compulsory infectious disease screening per capita among asylum seekers varied significantly depending on the content of the screening programmes, the price of the screening tests and the availability of follow-up services [285].

Recently, in preparation for the ECDC guidelines on infectious disease screening among migrants, separate systematic reviews assessing the effectiveness and cost-effectiveness of HBV, CHC and HIV screening among migrants in the EU/EEA were published [276, 300, 301]. Considering different elements in the screening pathway (Figure 2), evidence for effectiveness and cost-effectiveness of HBV screening (steps 2–4), treatment (step 7) and universal childhood vaccinations (step 8) were found. Selective HBV screening among migrant populations with CHB prevalence as low as 0.3% was likely to be cost-effective. [276]

Screening for hepatitis C among migrants from intermediate and high HCV prevalence countries in EU/EEA was found to be both effective and cost-effective based on evidence of test performance (step 4) and treatment outcomes (step 7). The systematic review identified studies demonstrating poor continuum of care influencing the efficacy of screening among general populations but no migrant population-specific information was available. [301] An earlier systematic review of studies examining hepatitis C screening cost-effectiveness showed a benefit for selective screening programmes among

high-prevalence populations such as migrants and PWID [284]. A British modelling study found provider-initiated opt-out screening of hepatitis C strategy among Asian-origin migrants with an HCVAb seroprevalence of 3.2% to be cost-effective [302].

HIV screening was found effective with respect to universal opt-out screening strategy and provider-initiated testing and counselling (PITC) (steps 2 and 3), test accuracy (step 4), and rapid testing (step 5). Screening for HIV was also deemed cost-effective especially when using rapid tests, although no studies among migrant populations were available. [300]

Most of the cost-effectiveness studies, however, do not consider the benefits of multiphasic screening or model the reductions in disease burden achieved with treatment and vaccinations [41, 303]. Neither did the studies assess cost-effectiveness in relation to migration status [41, 278]. Additionally migrants might have specific vulnerabilities to interrupted care and loss-to-follow-up, which influences disease progression and cost-effectiveness of treatment in comparison to general populations [41, 222].

Some studies have questioned acceptability of selective screening in comparison to universal strategies. Reluctance towards ethnic targeting of selective screening among migrants has been observed as a barrier for HBV and HIV testing in mixed methods studies from the UK [304-306].

In Finland, national guidelines on selective screening of blood-borne and sexually transmitted infections among migrants have been available since the 1980s [272, 307-310] (Table 5). Screening is offered for asylum seekers and refugees after arrival based on an individual risk assessment considering infection endemicity in the country of origin (TB incidence > 50 per 100,000, CHB prevalence > 2%, HIV prevalence among adults > 1%), arrival from conflict zones or refugee camps, family members or close contacts diagnosed with infectious diseases, and other risk factors related to personal medical history or risk behaviours [272, 311]. Screening for pulmonary TB is recommended for migrants from countries with TB incidence over 150 per 100,000 and for certain employees [312-314].

2.5.2.3 Case finding

In a broad sense, case finding refers to any attempts to identify infected among those at risk to bring them to treatment, and encompasses different screening approaches [240]. In communicable disease control practice, case finding generally refers to disease outbreak management. Case finding through partner notification enables informing, screening and treatment of close contacts of an infected [81].

Table 5. *Guidelines on screening of infectious diseases among migrants, refugees and asylum seekers in Finland.*

Guideline	Target group	Approach	Targeted infection(s): test
Medical board 1980 [309]	Refugees and adopted children	Universal	*Refugees:* • Hepatitis B: HBsAg *Adopted children:* • Hepatitis B: ALAT and ASAT, if elevated HBsAg • Syphilis: Cardiolipin
Medical board 1990 [310]	Refugees and asylum seekers	Universal	• Hepatitis B: HBs-Ag • HIV: HIV-Ab • Syphilis: Cardiolipin (VRDL) • Pulmonary tuberculosis: Chest X-ray
Ministry for Social Affairs and Health 1993 [308]	Refugees and asylum seekers	Selective multiphasic, voluntary	• Hepatitis B: HBs-Ag • HIV: HIV-Ab • Syphilis: Cardiolipin (VRDL) • Intestinal parasites for children under 7 years of age • Pulmonary tuberculosis for all above 7-years of age: Chest X-ray • Latent tuberculosis for unvaccinated children under 7-years of age: Mantoux
Ministry for Social Affairs and Health 2009 [272]	Refugees and asylum seekers	Selective multiphasic, voluntary	• Hepatitis B: HBsAg • HIV: HIVAgAb • Syphilis: TrpaAb if either HBsAg or HIVAgAb test is taken • Intestinal parasites for children under 16 years of age: Stool cyst microscopy • Pulmonary tuberculosis: Chest X-ray • Latent tuberculosis for unvaccinated children under 7-years of age: IGRA or Mantoux
Ministry for Social Affairs and Health 2014 [312]	Migrants from high tuberculosis incidence countries	Selective, voluntary	• Pulmonary tuberculosis: Chest X-ray
National Institute for Health and Welfare 2017 [313]	Migrants from very high tuberculosis incidence countries	Selective, voluntary	• Pulmonary tuberculosis: Chest X-ray

A systematic review and a meta-analysis concluded that assisted partner notification is more effective in increasing screening uptake among partners and identifying HIV-infected partners in comparison to passive referral. No studies on migrant populations were included in the review. [315] WHO recommends the implementation of voluntary assisted partner notification services for HIV [316]. A qualitative study among Somali-origin migrants in the UK found partner notification acceptable also in the context of HBV [306].

In Finland, the Communicable Diseases Act deems case finding and partner notification of patients with generally hazardous (syphilis) or notifiable communicable diseases (hepatitis B and C, HIV) mandatory [198]. However, contact tracing should primarily be performed in mutual understanding and collaboration with the index case [317].

2.5.2.4 Opportunistic screening

Opportunistic screening, as opposed to systematic or organized screening, occurs non-systematically and can be provider or self-initiated. Opportunistic screening complements systematic screening programmes and can influence their cost-effectiveness [274].

2.5.2.4.1 Provider-initiated opportunistic screening

PITC relies on provider's awareness of the possibilities of offering testing and secondly, on acceptability of testing [145, 270, 281]. PITC can encompass the offer of information on transmission, prevention and the significance of either test-negative or test-positive result [317]. Culturally sensitive PITC is effective but relatively costly intervention to increase test uptake among migrant populations [142, 264]. Peer-led approaches and bundling of PITC can also be effective [34].

In situations of concentrated or low-level HIV epidemics, WHO recommends indicator condition guided PITC. PITC should also be offered in STI services, services for most-at-risk populations, in ANS and accompanying treatment of TB. [318]

Finnish national HIV testing guidelines recommend PITC for persons with symptoms related to primary HIV infection or diagnosis of any AIDS-defining illness, other blood-borne or sexually transmitted infection, presenting with immunocompromised situation, or vulnerabilities for HIV infection. PITC should also be offered to persons vulnerable to HIV: migrants from high HIV prevalence countries, travellers to HIV-endemic areas, partners of HIV-positive individuals, sex workers and PWID. [145, 317] HCVAb test is recommended for newborns of HCVAb-positive mothers, PLWH, and persons at-risk of HCV through IDU or other unsafe injections, surgical operations or blood transfusions [223].

Opportunities of PITC exist at every healthcare contact. There is conflicting evidence on the use of healthcare services among migrants. A

recent systematic review concluded that migrant children appear to use less health services in comparison to non-migrants [319]. On the other hand, migrants in the EU/EEA use more emergency department services in comparison to native populations [320].

Several factors influence providers' awareness of the opportunities to offer testing such as history of immigration from a high-prevalence country or precarious socio-demographic determinants [94, 216]. Restricted access to public healthcare services direct migrants to migrant-sensitive services where healthcare professionals might be more ready to offer testing [321]. In France, migrant men in irregular situations had a higher probability of previous HIV testing in comparison to employed men with residency permits [216]. However, a recent mixed-methods systematic review demonstrated that migrants from high HIV prevalence countries were not frequently tested for HIV in primary care mainly due to providers' perceived barriers to offer testing including language barriers, perceived lack of competence in culturally sensitive sexual counselling as well as awareness of migrants' restricted entitlements to care [281].

According to a recent pan-European survey among migrants, 87% of the participants had accessed healthcare in the CCOR during the last 12 months and half of those who had visited healthcare reported that HIV testing was mentioned during the visit [207]. Similarly, 70.7–83.0% of HIV-positive migrants in Europe had attended health services within two years prior to diagnosis but only 24.8–38.9% recalled an offer of HIV test [209].

Although general practitioner was the most common health service visited after immigration, the majority of HIV diagnoses among migrants living with HIV in Europe were made in secondary or tertiary care, and among MSM in sexual health clinics [207, 209]. In a French study among migrants in Paris region, first-time HIV test after arrival occurred due to physician's request for 27.7% of migrant men and for 23.7% of migrant women visiting primary healthcare [216]. Finnish national HIV strategy emphasizes the role of primary care and low-threshold services in PITC [145].

Acceptability of PITC differs according to the testing settings, methodology, costs and patient populations. A review on HIV testing uptake among migrants and ethnic minorities showed 23–64% acceptability of PITC in studies conducted in Europe [142]. A high acceptability (91.4%) of multiphasic provider-initiated point-of-care CHB/HCVAb/HIVAb/syphilis testing was achieved among migrants in irregular situations visiting a free-of-charge migrant-sensitive health service in Northern Italy [322]. Uptake of an opt-out multiphasic HIV/HBV/HCV test at UK emergency departments was positively associated with migrant and ethnic origin even though only a modest acceptability of 39% was achieved [323]. Multiphasic screening of HIV/HBV/syphilis/stool parasitic infections offered for recently arrived asylum seekers at refugee shelters in Italy was accepted by 96% [324]. A qualitative study among migrants and healthcare providers in Spain found

that PITC is conceptually acceptable for both the service users and providers [325].

2.5.2.4.2 Self-initiated testing

Self-initiated testing is an important asset especially for reaching those not enrolled in screening programmes or visiting healthcare services. Self-initiated testing is increased by improving the availability and variety of innovative testing approaches, such as point-of-care rapid diagnostic tests, community testing, home-based sampling as well as self-testing [138, 142, 326].

In a French study among migrants, first HIV testing after migration was self-initiated among 25.9% of migrant men and 15.4% of migrant women visiting primary healthcare [216]. According to Finnish national guidelines, self-initiated HIV testing should be available without a physician's referral, anonymously and free-of-charge [317]. Access to self-initiated testing has not been evaluated at the national level.

WHO recommends HIV self-testing as an additional approach to increase the coverage of self-initiated HIV testing [316]. Many EU/EEA countries have developed or are planning to develop policies to support HIV self-testing [211, 327]. HIV self-testing became available in Finland in August 2018 [328].

Evidence on the acceptability and performance of self-sampling technologies among migrant populations is scarce [304, 305]. In a Dutch migrant population-based study, 1.4% of migrants had self-tested for HIV/STIs during the last 12 months and testing was associated with African origin, higher number of lifetime sexual partners and having had a condomless intercourse with a casual partner during the last six months [329]. In another cross-sectional study among migrants in France, the Netherlands and the UK, 1.9% of participants had self-tested for HIV during the last 12 months [330].

2.5.2.4.3 Low-threshold services

Low-threshold services aim at lowering barriers for counselling, testing, diagnosis and treatment of blood-borne and sexually transmitted infections, and usually take place in communities outside traditional healthcare settings.

Community-based awareness raising and testing services benefit from tailored, culturally sensitive approaches and have strong acceptability in the communities [208]. In settings with concentrated epidemics, low-threshold services can target key populations for prevention such as MSM, PWID, sex workers, adolescents, migrants and mobile workers [132].

WHO recommends community-based HIV testing and counselling services as an effective approach to increase HIV testing uptake [132]. In EU/EEA, community-based point-of-care HIV and HBV/HCV testing performed by non-medical staff has been implemented in one-third of the countries [138, 295]. A third of EU/EEA countries identify gaps in HIV prevention services for migrants and a half recognize stigma and discrimination limit the uptake of HIV prevention services [196].

Community-based non-clinical low-threshold services can reach good screening uptake among migrant populations [208]. A recent systematic review concluded that voluntary counselling and rapid testing for HIV among migrants was associated with an increase in HIV-testing uptake and receipt of results in comparison to conventional testing [300].

Enhanced HIV surveillance in UK demonstrated that ethnicity was associated with using community low-threshold services as opposed to specialist clinics or units within the public health system [331]. Attendance to community clinics was highest among the most vulnerable migrant populations: refugees, temporal workers and migrants in irregular situations [331]. Community outreach activities might also be beneficial in improving ANS coverage among migrant women [280].

Governments facing economic hardship and austerity measures, NGOs in Europe have become more prominent in providing preventive measures, testing and healthcare for migrants [10, 145]. Organizations' services are characterized by easy access, holistic approach, adaptable multidisciplinary services and confidentiality [332].

In Finland, NGOs have long traditions of providing community-based counselling and testing services for migrant sub-groups in various languages. Low-threshold counselling, substitution treatment, and syringe and needle exchange services for PWID in Finland have been found to be effective in preventing transmission of blood-borne infectious diseases [333, 334]. Substance abuse services and testing for migrants is provided by a network of community-based A-clinics (www.addictionlink.fi). The Global Clinic provides services including STI testing for migrants in irregular situations (www.globalclinic.fi). Hivpoint offers information, counselling and point-of-care HIV/HCV testing targeting especially migrants, MSM and travellers (www.hivpoint.fi). Pro-tukipiste offers support, health and social services for persons working in sex and erotic industry (www.pro-tukipiste.fi).

2.5.3 VACCINATIONS

HBV and HPV are currently the only blood-borne and sexually transmitted infections that can be prevented with vaccinations. WHO recommends immunization of all infants against hepatitis B as primary prevention. First dose of the HBV vaccine should be provided within 24 hours from birth. In addition to adopting universal childhood HBV immunization programme, WHO supports targeted catch-up HBV vaccinations among at-risk populations. [55]

Migrants in Europe have lower immunization rates and are vulnerable to vaccine-preventable diseases including hepatitis B [212, 335]. Migrants face specific barriers to vaccinations but evidence on effective interventions to address these barriers remains limited (Table 2) [212].

In a systematic review and a meta-analysis, seroprevalence of overall immunity to HBV (HBsAb seropositivity) was 39.7% among migrants from

intermediate and high-prevalence areas, and highest among migrants from areas with high CHB prevalence [106]. Recent cross-sectional studies among asylum seekers in Europe have found that 5.6–29.3% of study subjects have vaccine-derived immunity to hepatitis B (HBsAb seropositive with HBsAg and HBcAb seronegative) [294, 324, 336-339]. HBV immunity through vaccination was significantly higher among children and among migrants from the Eastern-Mediterranean region as compared to older age groups and other regions of origin [294]. Furthermore, evidence of current or spontaneously resolved infection (HBcAb seropositivity) was found among 12.8–62.2% of the asylum seekers [150, 294, 324, 336, 340-343].

The majority of countries in Europe have included universal HBV vaccine in the national vaccination programmes. Some, including Finland, have opted for targeted vaccination strategies. [344, 345] Finland has implemented targeted vaccination of at-risk populations since 1993, as cost-effectiveness studies to-date have not supported inclusion of universal hepatitis B vaccinations in the national vaccination programme [57, 346, 347]. Free-of-charge hepatitis B vaccine is offered for newborns of HBsAg or HCVAb-positive mothers, family members and partners of HBsAg-positive individuals and for newborns whose either parent originates from countries with HBV endemicity over 2%. Additionally, HBV vaccinations target PWID and their family, commercial sex workers, MSM, haemophilia patients and certain employees as well as victims of needle stick injuries. [348] All permanent residents and asylum-seeking children in Finland are entitled to vaccinations according to the national vaccinations programme [349]. Asylum-seeking adults are entitled only to necessary vaccinations [199]. Implementation and coverage of the hepatitis B vaccination programme among at-risk-populations has not been evaluated.

2.5.4 PUBLIC POLICIES

Public policies shape the national, regional and global public health responses to infectious disease epidemics. The key global actors in migrant health include the United Nations (UN) and the World Health Organization (WHO). The work of the UN is coordinated through several programmes such as the joint UN Programme on HIV/AIDS (UNAIDS), UN Migration Agency (International Organization for Migration, IOM), UN Refugee Agency (UNHCR) and the International Labour Organization (ILO). International human rights conventions recognize a universal human right to health regardless of residency status [350-352]. Specific rights of refugees were recognized in 1951 [16, 353].

UN adopted the 2030 agenda for Sustainable Development in a General Assembly held in October 2015 with 17 Sustainable Development Goals (SDGs), 169 associated targets and 232 indicators for development [354, 355]. Migrants, youth and PLWH are recognized as vulnerable populations in the

agenda. Target 3.3 calls for ending the HIV epidemic by 2030 and combating hepatitis and other infectious diseases [354]. HBV and HIV incidences by sex, age and among key populations have been included as indicators of progress towards target 3.3 [355]. ART coverage and International Health Regulations (IHR) core capacity index are included as indicators for the monitoring of achievement of universal health coverage (SDG3.8) [356]. SDG3 "Good health and wellbeing" is a key component of Finland's national implementation plan of the 2030 agenda [357, 358].

Following accelerating societal discussion on migration and the European migrant crisis in 2015, the UN general assembly adopted the New York Declaration for Refugees and Migrants in September 2016 [359]. The New York Declaration calls for global multisector collaboration in order to ensure the human rights for migrants and refugees, address the root causes of forced migration and strengthen safe and orderly migration routes, and started the process of development of the Global Compact for Safe, Orderly and Regular Migration coordinated by the IOM. Resolution on the Global Compact on Migration was adopted by the UN general assembly in December 2018 and is expected to bring fresh approaches to migration governance [360]. WHO is actively promoting the inclusion of migrant health as a prerequisite for development in the compact's agenda, especially focusing on enhancing health monitoring among migrants and ensuring universal health coverage [361].

International Health Regulations (IHR) have been adopted and ratified by all WHO member states, including Finland. The IHR aims to strengthen the global efforts to prevent and control cross-border health threats such as infectious diseases [362]. Migration and mobility are not specifically mentioned in the IHR, although large influx of migrants could constitute a public health emergency of international concern. Implementation of the IHR is monitored through a self- and peer-evaluation system, and reported to the World Health Assembly annually [363, 364]. Joint External Evaluation of IHR Core Capacities in Finland in 2017 recommended ensuring vaccination coverage especially among asylum seekers and migrants in irregular situations [365].

WHO's Global Health sector strategies on viral hepatitis and HIV 2016-2021 contribute to the achievement of the SDGs [366, 367]. The strategic approaches to achieve the elimination of viral hepatitis include vaccinations, prevention of MTCT, stopping iatrogenic infections, harm reduction, and treatment [366]. For HIV, the key strategic interventions include enhancing prevention through new biomedical tools, adoption of the "90-90-90" target, and focusing on hard-to-reach populations including mobile populations [367]. The 90-90-90 target by UNAIDS aims at improved continuum of HIV care by (1) achieving diagnosis of 90% of all HIV-infected people; (2) establishing ART for 90% of PLWH; and (3) sustaining viral suppression among 90% of those on ART [368]. Migrants are mentioned as a key population potentially vulnerable and at-risk for viral hepatitis and HIV [366, 367]. UNAIDS strategy for

2016–2021 and the "90-90-90" target urge for broadening options for screening in communities, at home and innovative public-private partnerships [368, 369]. The Global Vaccine Action Plan 2011–2020 also urges approaches to reach especially urban migrants for vaccinations [370].

In Europe, migrant women especially suffer exclusion and ill-health due to several overlapping vulnerabilities, including infectious diseases, and the European health policy framework suggests addressing these issues by combatting social exclusion processes [371]. The Dublin Declaration on Partnership to Fight HIV/AIDS in Europe and Central Asia in 2004 enforced the collaboration between WHO Regional Office for Europe and ECDC for the control and monitoring of the HIV epidemic also among migrants and mobile populations in the area [372]. In the context of concentrated HIV/AIDS epidemic, the European Action Plan for HIV/AIDS acknowledges the need to develop targeted approaches to reach key population at high risk such as migrants, and to ensure universal access to testing and care, and also supports the removal of mandatory HIV testing based on migration status [373]. The strategy and action plan for refugee and migrant health in Europe calls for ensuring coordination, enhanced surveillance and migrant-sensitive interventions to control infectious disease threats [374].

In Finland, the national hepatitis C, HIV and SRH strategies acknowledge migrants as key population for public health action [145, 223, 270]. National hepatitis C strategy 2017–2019 supports HCV screening after arrival among asylum seekers from high-prevalence settings [223]. Key strategic approaches to HIV among migrants include enhancing health literacy, early diagnosis through migrant-sensitive services and preventing post-migration infections. Universal access to testing and treatment should be ensured for all migrant populations. [145]

2.6 SUMMARY OF THE LITERATURE REVIEW AND GAPS IN KNOWLEDGE

Trends in international migration and mobility are likely to persist resulting in increasingly diverse societies that will require health systems to adapt. Migrants are vulnerable to sexually transmitted and blood-borne diseases including hepatitis B and C, HIV and syphilis, and have a disproportionately high disease burden in low-prevalence countries, such as Finland.

The epidemiology of hepatitis B and C, HIV and syphilis among migrants mirrors the prevalence of infections in the countries of origin, although selective migration is likely to explain the somewhat lower risk for infection among those who decide to migrate as compared to those who decide to stay. A proportion of infections occurs post-migration as a result of specific vulnerabilities to infections related to health literacy, health service coverage and behavioural factors. While several strategies have been adopted to

address these vulnerabilities, their implementation and effectiveness have rarely been evaluated.

Epidemiology of infectious diseases among migrants is specific to time, place and population. In order to address the gaps in public health response to hepatitis B and C, HIV and syphilis among migrants, evidence is needed on the infection prevalence, population groups at increased risk, health seeking behaviours and effectiveness of the current approaches.

3 AIMS OF THE STUDY

The aims of the study are

1. to assess the feasibility of infectious disease screening in a migrant population health survey context with respect to participation and acceptability of screening (publications I and II)

2. to estimate the burden of hepatitis B and C, HIV, and syphilis among different migrant populations in Finland (publications I and III)

3. to evaluate the implementation and coverage of infectious disease screening among different migrant populations in Finland (publications I, III and IV)

4. to describe HIV-related knowledge, attitudes and practices of young adult asylum seekers (publication IV).

4 MATERIALS AND METHODS

4.1 STUDY POPULATIONS

4.1.1 MIGRANTS WITH LONG-TERM RESIDENCY (I, II)

EU nationals or nationals to third countries who have a residency permit to Finland, and have lived or have the intention to live in Finland for a minimum of one year can be registered in the population information system (PIS) with a municipality of residence. After registration persons have full access to public health services, including prevention and treatment of infectious diseases. [197] Emigration data in the PIS is based on personal notifications and register corrections [375].

The largest resident migrant populations in Finland in 2010 were persons born in FSU or Russia, Estonia, Iraq or Iran, and Somalia, in descending order, representing 38% of the total migrant population in 2010 [30]. Majority of migrants from Iraq, Iran and Somalia have received residency through refugee status whereas migrants from FSU and Russia have immigrated due to study, work or family ties [376].

Publications I and II used data from the Maamu survey which included three of the largest resident migrant populations in Finland in 2010. Inclusion criteria for the Maamu survey were: (1) Kurdish, Russian or Somali origin; (2) 18 to 64 years of age; (3) having lived in Finland for at least one year; and (4) living in Espoo, Helsinki, Vantaa, Tampere, Turku or Vaasa cities. Kurdish origin was defined as being born in Iran or Iraq and speaking Kurdish as mother tongue. Russian origin was defined as being born in Russia or FSU and speaking Russian or Finnish as mother tongue. Somali origin was defined as being born in Somalia. No participants were excluded. [376]

Publication I included all individuals invited to participate in the Maamu survey and who had immigrated to Finland after January 1, 1995. The immigration year was limited in order to ensure that if an individual had been diagnosed with a notifiable infectious disease, the notification was registered in the National Infectious Disease Register (NIDR).

Publication II included participants in the Maamu pilot and Maamu surveys who lived in Helsinki.

4.1.2 ASYLUM SEEKERS (III, IV)

Asylum seekers are migrants seeking for international protection in a foreign country. While waiting for a decision on the residency permit application based on refugee status, asylum seekers are not considered permanent

residents in Finland and are not registered in the PIS. [13] Once receiving a residency permit, asylum seekers are registered in the PIS and assigned a municipality of residence. The Finnish Immigration Service is responsible of the processing of the asylum applications and organization of services, including healthcare services, for asylum seekers. Finnish Immigration Service also maintains register on asylum applications. [199]

Publication III included all asylum seekers who applied for asylum in Finland in 2015–2016. Persons with unknown or with no nationality were excluded.

Publication IV included participants in the TIE survey aged 20 to 25 years. Inclusion criteria for the TIE survey were (1) having asylum application in process; (2) 16 to 25 years of age; (3) originating from Middle East and North Africa [377], the FSU countries or SSA [377]; and (4) living in one of the three selected reception centres in Finland: Pansio reception centre in Turku, or Kaarlenkatu or Punavuori reception centres in Helsinki. No participants were excluded.

4.1.3 GENERAL POPULATION YOUNG ADULTS (IV)

General population young adults were chosen as a control group. Young adults of 20–25 years of age represented 6% of the Finnish population in 2014 [30]. Children and young people are considered as a key population for SRH promotion in Finland. Often multiple important life changes occur in young adulthood such as engaging in first longer intimate relationships and young adulthood can involve increased risk behaviours for blood borne and sexually transmitted infections. [270]

Publication IV included participants in the World Aids Day survey in 2014 (WAD 2014) aged 20 to 25 years. The inclusion criteria for the WAD 2014 survey were (1) 20 to 29 years of age and (2) having electronic contact information in the Taloustutkimus Ltd.'s register. No participants were excluded.

4.2 RESEARCH QUESTIONS

Research questions relevant for each study aim are summarized in Table 6. PICOT approach was used to frame the research questions according to population of interest (P), issue or intervention (I), comparison (C), outcome (O), time and setting (T) [378].

Table 6. *Summary of research questions based on the PICOT framework [378].*

Study aim	Research question (PICOT)	Publication
Feasibility of screening	Did the notification prevalence of hepatitis B, hepatitis C, HIV and syphilis (O) differ among participants (P) and non-participants (C) in the Maamu survey (T)?	I
	What was the acceptability (O) of HBsAg, HCVAb, HIVAgAb and TrpaAb screening (I) among migrants who immigrated after 1995 (P, C) in the Maamu survey (T)?	I
	What factors were associated with the acceptability (O) of HIVAgAb test (I) among adult migrants resident in Helsinki (P, C) in the Maamu survey and Maamu survey pilot (T)?	II
Seroprevalence	What was the seroprevalence (O) of HBsAg, HCVAb, HIVAgAb, and TrpaAb among migrants who immigrated after 1995 (P) who were screened (I) in the Maamu survey (T)?	I
	What was the seroprevalence (O) of HBsAg, HIVAgAb and TrpaAb among asylum seekers (P) who were screened (I) in Finland during 2015–2016 (T)?	III
Implementation of screening	What was the self-reported coverage (O) of infectious disease screening (I) among migrants immigrated after 1995(P) in the Maamu survey (T)?	I
	What was the coverage (O) of HBsAg, HIVAgAb and TrpaAb screening (I) among asylum seekers (P) in Finland during 2015–2016 (T)?	III
	What was the self-reported coverage (O) of HIV screening (I) among asylum seekers (P) in comparison to the general population (C) in the TIE and WAD 2014 surveys (T)?	IV
	What was the delay (O) from immigration to hepatitis B or C, HIV or syphilis notification (I) among migrants who immigrated after 1995 (P) in the Maamu survey (T)?	I
	What was the delay (O) from immigration to HBsAg, HIVAgAb and TrpaAb screening (I) among asylum seekers (P) in Finland during 2015–2016 (T)?	III
Knowledge, attitudes and practices	How did the HIV-related knowledge, attitudes and practices (O) among young adult asylum seekers (P) differ as compared to general population (C) in TIE and WAD 2014 surveys (T)?	IV

PICOT framework = Population (P), Issue or intervention (I), C (Comparison), Outcome (O) and Type of study (T). Maamu = Migrant Health and Wellbeing Survey. TIE = TIE survey. WAD 2014 = World Aids Day survey in 2014.

4.3 SURVEYS

4.3.1 MIGRANT HEALTH AND WELLBEING SURVEY AND PILOT SURVEY

Maamu survey was a cross-sectional observational population-based health interview and examination survey among adult Kurdish, Russian and Somali-origin migrants in Finland during 2010–2012. Simple random sampling stratified by origin and place of residency was performed from the PIS in 2010. In total 3,000 migrants – 1,000 from each origin – were invited to participate in the survey. [376]

Participation in the Maamu survey was voluntary and participants provided a written informed consent for the health interview, examination and laboratory tests separately. Participants' travel expenses to the survey location by public transport were covered and they were given a small voucher to a local cafeteria as remuneration for their participation. [376]

Health interviews and examinations in the Maamu survey were performed by nurses speaking Finnish, Kurdish Soran, Russian or Somali. The health interview included questions on socio-demographic background, health service use and previous medical history including TB. In addition to the standard interview protocol, a short protocol including only the most essential questions was developed in order to increase the participation for the survey. [376]

Current symptoms of active pulmonary TB, HIV-related knowledge, participation in previous HIV testing and history of blood-borne infections were surveyed during the health examination. HIV KAP was assessed using the UNGASS indicator questions including an additional question on the prognosis of HIV under treatment [248].

All participants in the health examination were offered screening for HBV, HCV, HIV and syphilis. Blood samples were drawn in a laboratory after receiving the written consent. Screening tests and the confirmatory tests, apart from confirmatory HCV tests, were performed in the ANS laboratory of the National Institute for Health and Welfare. HCVAb-positive test results were confirmed by HUSLAB, the laboratory of Helsinki University Central Hospital and the Hospital District of Helsinki and Uusimaa. All screening tests had over 98% specificity and sensitivity [88, 379-387] (Table 7). Samples positive for Treponema-specific antibodies were further analysed with Rapid Plasma Reagin to assess the infection activity [85, 88].

Before beginning of the official data collection, Maamu survey was piloted in Helsinki in 2010 to test the health interview and examination protocol. Fifty participants from each migrant population were randomly selected from the PIS. Then inclusion criteria for the pilot were the same as for the Maamu survey except that the city of residency was limited to Helsinki. [376]

Table 7. *Screening tests used in Maamu survey and in screening of the asylum seekers.*

Infection	Primary test	Confirmatory test
Hepatitis B	ARCHITECT® HBsAg Qualitative (Abbot, Chicago, Illinois, USA) [380] • Purpose: HBsAg detection • Method: Chemiluminence microparticle immunoassay	AXSYM® Confirmatory (Abbot, Chicago, Illinois, USA)[a] [381] • Purpose: HBsAg detection • Method: Microparticle enzyme Immunoassay
Hepatitis C[a]	ARCHITECT® Anti-HCV (Abbot, Chicago, Illinois, USA) [382] • Purpose: HCVAb detection • Method: Chemiluminence microparticle immunoassay	INNOTEST® HCV Ab (Fujirebio, Malvern, Pennsylvania, USA) [383] • Purpose: HCVAb detection • Method: Enzyme Immunoassay
HIV	ARCHITECT® HIV Ag/Ab Combo (Abbot, Chicago, Illinois, USA) [384] • Purpose: Detection of HIV p24 antigen and antibodies to HIV-1 and HIV-2 • Method: Chemiluminence microparticle immunoassay	INNO-LIA® HIV (Fujirebio, Malvern, Pennsylvania, USA) [385] • Purpose: Detection and differentiation of antibodies to HIV-1 and HIV-2 • Method: Line immunoassay
Syphilis	ARCHITECT® Syphilis TP (Abbot, Chicago, Illinois, USA) [386] • Purpose: Detection of antibodies to *Treponema pallidum* • Method: Chemiluminence microparticle immunoassay IMMULITE® 2000 Syphilis (Siemens, Munich, Germany)[b] [379] • Purpose: Detection of antibodies to *Treponema pallidum* • Method: Quantitative immunoassay	INNO-LIA® Syphilis (Fujirebio, Malvern, Pennsylvania, USA)[a] [387] • Purpose: Detection of antibodies to *Treponema pallidum* • Method: Line immunoassay
[a]Used only in Maamu survey; [b]Used only in screening of the asylum seekers.		

Based on experience from the pilot, small changes to the survey protocol were made, including enhancement of the pre-test counselling for HIV in order to motivate participation in the HIV testing. Enhanced pre-test counselling included normalization of testing as well as explaining the benefits of testing for the community and for purposes of the survey. [376] Factors influencing the acceptability of HIV testing, such as enhanced counselling among others, were assessed (II).

Migrants who had accepted testing in Maamu survey were considered participants and the rest as non-participants. Notifications of hepatitis B and C, HIV and syphilis in the NIDR during January 1, 1995 and December 31,

2009 were compared between participants and non-participants in the survey to assess non-participation (I).

Among those who accepted testing, the proportion and risk factors for any missed diagnosis were assessed (I). Missed diagnosis was defined as a test-positive case in Maamu survey without a prior notification in NIDR. Delay from immigration to notification was calculated by comparing the immigration and notification dates. Delays were grouped into three categories: (1) notification within one year of immigration; (2) notification after one year post-immigration but prior to Maamu survey; and lastly (3) diagnosis at Maamu survey.

4.3.2 TIE SURVEY

The TIE survey was conducted as a part of project for prevention and early diagnosis of HIV and TB among young asylum seekers in Finland. The project took place during 2012–2015 and was coordinated by the Finnish Lung Health Association and received funding from the European Refugee Fund [388, 389].

TIE survey was a cross-sectional observational health survey on HIV and TB-related KAP among young adult asylum seekers in Finland in 2014. The participants were recruited by convenience sampling by nurses working in the reception centres. Participation was voluntary and a written informed consent was obtained from the participants. [388, 389]

Participants filled in an anonymous written 50-item structural questionnaire in Arabic, English, Russian, Somali or Soran. The questionnaire included items on socio-demographic background and HIV and TB-related KAP. [389] HIV knowledge was assessed using the UNGASS indicator questions developed for monitoring of the global HIV response (Table 8) [390]. An additional question about the knowledge of the availability of medication to treat HIV was posed. HIV related attitudes were surveyed by assessing attitudes towards PLWH. HIV related practices were evaluated by assessing the proportion previously tested for HIV.

Questionnaires were filled in a classroom setting and interpreters helped those with reading difficulties. All questions had either a Likert scale or an "I don't know" option. Answering all questions was not obligatory. The reception centre nurse and the survey doctor were present to answer possible questions. After completion of the survey, participants received a chocolate bar as a token. [389]

4.3.3 WORLD AIDS DAY SURVEY

WAD surveys have been performed for several years among different target groups and the results are typically published on the World Aids Day on the December 1. The focus of the surveys has been at HIV-related KAP. WAD

surveys have been designed and coordinated by a network of NGOs and patient organisations working with HIV in Finland.

Table 8. *UNGASS core indicator for monitoring young people's knowledge about HIV prevention; 2002 version and 2010 update* [248, 249].

No.	Question	Correct answer
UNGASS1	2002: Can the risk of HIV transmission be reduced by having sex with only one faithful, uninfected partner?[a]	Yes
	2010: Can the risk of HIV transmission be reduced by having sex with only one uninfected partner who has no other partners?	
UNGASS2	2002: Can the risk of HIV transmission be reduced by using condoms?[a,b]	Yes
	2010: Can a person reduce the risk of getting HIV by using a condom every time they have sex?	
UNGASS3	Can a healthy-looking person have HIV?[a,b]	Yes
UNGASS4	Can a person get HIV from mosquito bites?[a,b]	No
UNGASS5	Can a person get HIV by sharing food with someone who is infected?[a,b]	No
[a]Used in TIE survey; [b]Used in WAD 2014 survey.		

WAD 2014 was a cross-sectional observational population-based online health survey on HIV-related KAP among the general young adult population in Finland. A commercial market research centre (Taloustutkimus Ltd.) performed the e-survey in 2014. The company adheres to the standards of International Chamber of Commerce and European Society for Opinion and Marketing Research aiming to improve the quality and reliability of online surveys. Taloustutkimus Ltd.'s online roster was established in 1997. Members of the roster have been recruited from previous studies that have sampled individuals from the PIS and the roster is constantly updated.

A simple random sample of 5,931 individuals was selected from the roster. An invitation letter was sent to the individuals in the sample via e-mail to participate in the survey. The e-mail contained a personal password to a Computer Aided Web Interview portal. Participation in the survey was voluntary. Logging into the portal and participating in the survey was taken as consent to participate. Answering all questions was obligatory in order to complete the survey. Participants did not receive any remuneration for their participation. The 17-item survey on HIV-related KAP included UNGASS indicator questions 2 to 5 and was only available in Finnish (Table 8). The survey was accessible from October 20–30, 2014, and was closed after the target number of 1,000 participants had registered.

HIV-related KAP of the general population in the WAD 2014 survey was compared to that of the young asylum seekers in the TIE survey and risk factors for exposure to previous HIV test were assessed (IV).

4.4 REGISTERS

4.4.1 NATIONAL INFECTIOUS DISEASE REGISTER

The National Institute for Health and Welfare in Finland governs several national health and social sector registers, such as the NIDR [391]. The previous infectious disease notification system was reformed following updates in the Communicable Diseases Act (586/1986) in 1992 [392, 393]. NIDR was established in 1994 and was fully functional by the beginning of 1995 [391, 394]. NIDR is linked to the PIS for updates in country of birth, municipality of domicile and residency, nationality and death.

Laboratories and physicians are obliged by the Communicable Disease Act (1227/2016) to notify specific infectious disease findings and diagnoses to the register [198]. Accredited clinical laboratories report findings of approximately 70 different microbes and all findings from blood and cerebrospinal fluid [287]. Physicians' notifications contain additional, infection-specific clinical and socio-demographic information relevant for epidemiological surveillance [124]. Migration-specific parameters in the NIDR are infection-specific and have evolved with time, and currently include country of birth, nationality, year of immigration and probable country of infection.

A case in NIDR is created by either laboratory's or physician's notification, or both. Finnish Personal Identification Code (PIC) and name are used to identify notifications belonging for the same case and the same person. Notification for temporary residents, such as asylum seekers and tourists, are registered with a temporary PIC which can be later merged with an official PIC automatically or manually. For hepatitis B and C, HIV and syphilis, notifications within 50 years are considered as a single case.

Since 1995, there have been minor changes in the case criteria for hepatitis B and C, HIV and syphilis in the NIDR. Cases of CHB have been registered since 1994 based on laboratories' notifications of antigen or antibody positivity, or physicians' notifications of microbiologically confirmed cases. After 2017, CHB cases are based solely of laboratory's notification.

Cases of hepatitis C have been registered in the NIDR since 1994 based on laboratories' notifications of HCV-RNA or HCVAb positivity. Since 1998 hepatitis C cases have been formed of either laboratories' notifications or of physicians' notifications of microbiologically confirmed cases.

Cases of HIV have been registered in the NIDR since 1983 based on either laboratories' notifications of HIV-RNA, antigen or, in case of individuals over 18 months of age, antibody positivity, or on physicians' notifications of microbiologically confirmed cases. During 1983–2007, notifications of HIV were recorded in a separate HIV register and imported to NIDR in 2007.

Syphilis cases in the NIDR have since 1994 been based on laboratories' notifications of antigen or antibody positivity, or on physicians' notifications of microbiologically or clinically confirmed cases. Since 2017 laboratories have also been able to notify NAAT-positive syphilis cases.

The NIDR case criteria of CHB, CHC, HIV and latent syphilis have minor differences in comparison to the case criteria adopted by the ECDC and Centers for Disease Control and Prevention (CDC) [395, 396]. Since 2012, ECDC and CDC both define CHB by HBsAg, HBeAg or HBV-DNA positivity with simultaneous anti-HBcAb IgM negativity, or a HBsAg, HBeAg or HBV-DNA positivity on two occasions at least six months apart [111, 395, 396]. For CHC cases, ECDC requires HCV-RNA or HCV-core-Ag positivity or HCVAb positivity in two samples in a person older than 18 months without evidence of resolved infection [123, 395]. CDC defines CHC according to HCV-RNA or HCV-core-Ag positivity with HCVAb positivity [396]. Both ECDC and CDC define HIV cases among individuals over 18 months of age based on HIV-NAAT, antigen or antibody positivity and require information on confirmation of the diagnosis. Separate case criteria are provided for individuals less than 18 months of age. [395, 396] CDC also considers HIV cases with only clinical diagnosis [396]. For a latent syphilis case, both ECDC and CDC require treponemal and non-treponemal test positivity with CDC further defining requirements for non-treponemal test increase [395, 396].

Publication I considered notifications of acute or chronic hepatitis B, hepatitis C, HIV and syphilis in NIDR between January 1, 1995 and 31st December 31, 2009 for persons in the Maamu survey sample who had immigrated after January 1, 1995. Information was retrieved based in PICs. Notification prevalence between the participants and non-participants was compared to assess the representativeness of the participants and the external validity of the seroprevalence estimates. A seropositive case in Maamu survey without a previous notification in NIDR between January 1995 and December 2009 was considered as a missed diagnosis.

4.4.2 HEALTHCARE PROCUREMENT REPORTING

Since 2012, Finnish Immigration Service has procured health services including infectious disease screening from two national private healthcare service providers [397]. The service providers report regularly to Finnish Immigration Service on the number and kind of services procured per age group. Monthly reporting is due by 15th of the following month resulting in a two to six-week delay from screening event to reporting. Finnish Immigration Service maintains statistics on asylum applications [31].

Publication III used healthcare procurement register data on procurements of HBsAg, HIVAgAb and TrpaAb among asylum seekers in Finland during 2015–2016. The number and timing of screening tests performed among children and adult asylum seekers (numerator) was evaluated against the number of asylum seekers eligible for screening

(denominator). TrpaAb screening was used as an indicator of any blood screening since TrpaAb screening is recommended for all whom are screened for either HBsAg or HIVAgAb, or both. A target time frame for screening was set at of three months from arrival was adopted. [272]

4.5 STATISTICAL ANALYSES

Statistical analyses were performed using IBM SPSS Statistics versions 22 (II), 23 (IV) and 24 (I) and Microsoft Excel 2010 (III). Likert scales were recoded into bi- or trinomial variables when necessary. The null hypotheses were tested using Pearson's Chi-squared (II-IV) or SPSS Complex Samples logistic regression (I and IV). P-values were two-tailed and considered significant if <0.05. Confidence intervals were calculated according to Wald (III) or by bootstrapping (IV). Average delay to screening was considered as the difference in means of arrival and screening (III).

Multivariable logistic regression analysis was used to assess associations between the outcome variable and the independent variables. Missed diagnosis (I), refusal to test (II) and previous HIV test (IV) were used as dependent variables. Interactions between independent variables were tested for publication I. Selection of independent variables for the final regression models was performed with $p<0.2$ in the univariate comparison (I, IV) or using Akaike Information Criteria (II). Continuous variables were used as covariates and odds ratios (ORs) calculated for annual increase (I).

Population weights were developed for population-based samples to balance for non-participation (I, IV). For Maamu survey, inverse population weights were calculated based on Bayesian Information Criterion, using age group, sex, origin, city of residency and marital status as auxiliary variables (I) [376, 398]. Separate weights were developed for participants in the health interview with standard and short protocols, and for the health examination. Population weights were also developed for participants in the WAD 2014 survey, using age group, sex and region of origin as auxiliary variables (IV). No population weights were developed for the Maamu pilot survey and hence analyses for publication II were performed without weights.

4.6 ETHICAL REVIEW

The study was performed according to research ethical principles outlined in the Declaration of Helsinki [399]. Study protocols for publications I, III (325/13/03/2009 §146) and IV (289/13/03/00/2013 §198) were approved by the Coordinating Ethics Committee of the Helsinki and Uusimaa Hospital District. Study design of publication II received ethical approval from the Research Ethical Committee of the National Institute for Health and Welfare (§758, March 16, 2017).

5 RESULTS

5.1 BASIC CHARACTERISTICS

Migrants with long-term residency (publications I and II) and asylum seekers (publications III and IV) were included in the analyses. Numbers of participants included in each publication are presented in Table 9.

Table 9. *Summary of the included participants.*

Publication	Description of included participants	Sample size	Proportion of women; %(n[b])
I	Kurdish, Russian and Somali-origin adult migrants who immigrated after January 1995 belonging to the Maamu sample	2,173	53.7 (1,140)[a]
I	Kurdish, Russian and Somali-origin adult migrants who immigrated after January 1995 and who participated in Maamu survey health examination	1,071	53.9 (583)[a]
I	Kurdish, Russian and Somali-origin adult migrants who immigrated after January 1995 and who were screened for HBsAg, HCVAb, HIVAgAb or TrpaAb in Maamu survey	1,000	54.6 (553)[a]
II	Kurdish, Russian and Somali-origin adults migrants resident in Helsinki who participated in Maamu survey or Maamu survey pilot	386	57.6 (220)
III	Asylum seekers in Finland during 2015–2016	37,614	20.8 (7,946)
III	Asylum seekers in Finland during 2015–2016 screened for HBsAg	22,144	NA
III	Asylum seekers in Finland during 2015–2016 screened for HIVAgAb	13,768	NA
III	Asylum seekers in Finland during 2015–2016 screened for TrpaAb	22,016	NA
IV	Asylum seekers aged 20 to 25 years who participated in TIE survey	47	21.7 (10)
IV	General population aged 20 to 25 years who participated in the WAD 2014 survey	485	49.2 (301)[a]

[a]Weighted proportion; [b]Crude n; NA = Not available

Data on migrant specific vulnerabilities was available for Kurdish, Russian and Somali-origin migrants in the Maamu survey and to a limited extent for young adult asylum seekers in the TIE survey (I, IV).

At the time of the Maamu survey, Russian-origin migrants were older (average 38.6 years) than migrants of Kurdish (34.9 years) or Somali (mean 32.4 years) origin ($p<0.01$) (I). Migrants of Russian origin were also older at the time of immigration (average 29.6 years) as compared to Kurdish (25.5 years) or Somali origin (23.6 years) migrants ($p<0.01$).

Reasons for immigration differed significantly between the migrant populations with long-term residency. Only a percentile of Russian-origin migrants had received residency permit based on a refugee status compared to Kurdish or Somali-origin migrants of whom three fourths had immigrated as refugees or asylum seekers ($p<0.01$). A lower proportion of Somali-origin migrants were employed at the time of the survey (16.1%) compared to Kurdish or Russian-origin migrants (37.7% and 47.8% respectively, $p<0.01$).

Level of education differed significantly between migrant populations in the Maamu survey. Secondary education or more was reported by 78.5% of the Russian, 41.7% of Kurdish and 18.8% of Somali-origin migrants ($p<0.01$). Good ability to read in Finnish or Swedish was reported by 83.9% of all participants to the Maamu survey without differences according to origin ($p=0.89$). (I) The proportion of individuals with only primary education was higher among young asylum seekers in the TIE survey in comparison to young adult general population in the WAD 2014 survey (62.2 vs. 13.4% respectively, $p<0.05$). One-sixth (17.0%) of young adult asylum seekers could read poorly or not at all in their mother tongue and one-fourth (23.4%) had poor writing skills. (IV)

Migrant women of Kurdish, Russian or Somali origin were older (average 36.4 vs. 34.5 years, $p=0.03$) and had resided in Finland for a longer period (average 9.4 vs. 8.7 years, $p<0.01$) than men. Somali-origin women were less educated than men (11.3 vs. 30.7% with tertiary education respectively $p<0.01$) and had poorer literacy (77.9 vs. 93.4% literate in Finnish or Swedish respectively, $p<0.01$). A significantly larger proportion of Russian origin women reported previous abortions (55.8%) compared to Kurdish (22.4%) or Somali (1.3%) origin women ($p<0.01$). Proportion of women with at least one previous delivery did not differ between migrant populations. (I) The proportion of women in the TIE survey was smaller than the weighted proportion of women in the WAD 2014 survey (Table 9) (IV).

History of previous IDU was rare with only two persons reporting lifetime injections. Nearly all (97.5%) Russian-origin migrants, 59.6% of Kurdish migrants and 15.7% of Somali-origin migrants reported VFR return travelling to previous country of origin.

5.2 PARTICIPATION AND ACCEPTABILITY OF SCREENING

5.2.1 PARTICIPATION (I)

Maamu health interview and examination survey invited 3,000 Kurdish, Russian and Somali-origin adult migrants randomly selected from the PIS. Of them, 827 (27.6%) had immigrated before January 1, 1995, and were excluded from the analyses (Figure 3). Participation in the survey was highest among Russian-origin migrants in comparison to Kurdish and Somali-origin migrants ($p<0.01$). Of the survey participants, 1,071 took part in the health examination and were offered screening for hepatitis B and C, HIV and syphilis.

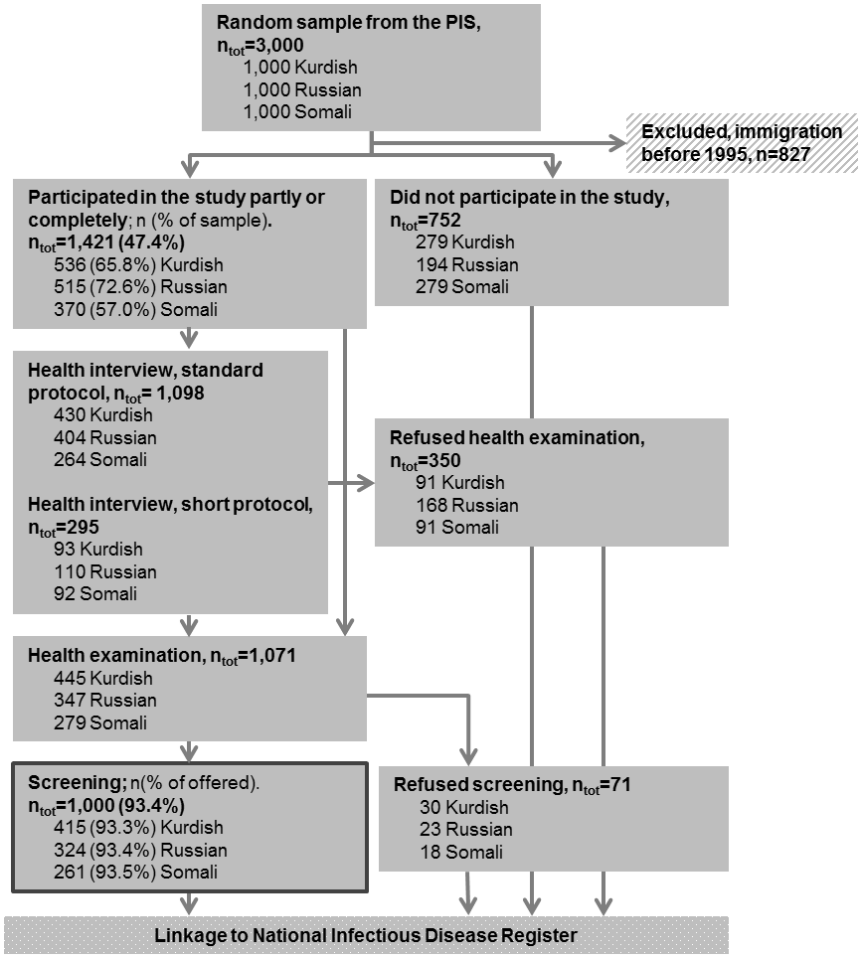

Figure 3 Flow chart on participation in hepatitis B and C, HIV and syphilis screening, and register linkage in the Maamu survey. PIS=Population Information System.

Notification prevalence of acute or chronic hepatitis B, HCV or syphilis did not differ among the 1,000 participants and 1,173 non-participants in the Maamu survey blood screening (p = 0.39, 0.99 and 0.59 respectively). No notifications of HIV were observed among the Maamu survey sample.

Health examination participation rate was lower among residents of Helsinki (36%, n=334) and in the pilot survey (35%, n=52) than among all participants in Maamu survey (49%, n=1,071, Figures 3 and 4).

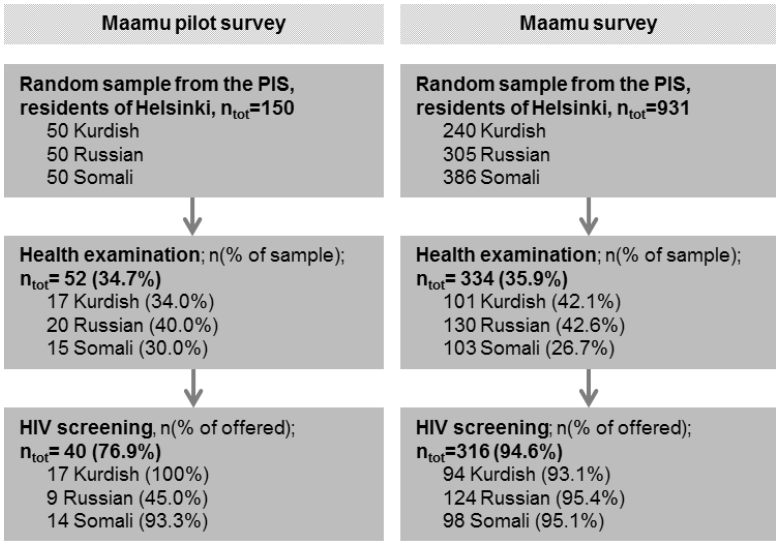

Figure 4 Flow chart on participation in HIV screening during Maamu survey and pilot survey in Helsinki. PIS=Population Information System.

5.2.2 ACCEPTABILITY OF SCREENING (I, II)

Of all the Maamu survey participants who had immigrated after January 1995, 1,071 (58.1%) took part in the health examination and were offered screening for hepatitis B and C, HIV and syphilis (Figure 3). At least one screening test was accepted by 1,000 participants (93.4%) (Table 10). Acceptability of any test or specific tests was not associated with origin or age. Acceptability of any test was significantly higher among women (94.9%) in comparison to men (91.6%, p=0.03). (I)

Acceptability of HIV testing increased from 76.9% in the pilot survey to 94.6% in the Maamu survey in Helsinki after introduction of enhanced pre-test counselling (Figure 4). Improvement was mostly due to increase in acceptability among the Russian-origin migrants. (II)

Predictors for the acceptability of HIV screening were evaluated among both the participants in Maamu survey health examination in Helsinki and pilot survey. In multivariate logistic regression model, lower risk of refusal of HIV screening was associated with unemployment (adjusted OR 0.35, 95%

CI 0.15–0.82), poor ability to understand spoken Finnish or Swedish (0.09, 0.01–0.82) and enhanced pre-test counselling (0.11, 0.04–0.27). A borderline significant association was observed with living alone (0.21, 0.04–1.0). (II)

Table 10. *Acceptability of screening for hepatitis B/C, HIV and syphilis among the participants in the Maamu health examination; % (n).*

	HBsAg/ HCVAb	HIVAgAb	TrpaAb	Any test
Kurdish	93.2 (413)	91.9 (409)	92.6 (412)	93.3 (415)
Russian	93.1 (323)	92.8 (322)	92.5 (321)	93.4 (324)
Somali	93.2 (260)	90.0 (251)	91.4 (255)	93.5 (261)
Total	93.2 (996)	91.7 (982)	92.3 (988)	93.4 (1,000)

5.3 BURDEN OF HEPATITIS B AND C, HIV AND SYPHILIS

5.3.1 SEROPREVALENCE (I, III)

Seroprevalence of HBsAg, HIV and TrpaAb was assessed among participants in the Maamu survey (I) and among asylum seekers to Finland in 2015–2016 (III). HCVAb seroprevalence was assessed only in the Maamu survey (I).

Among Kurdish, Russian and Somali migrants who had immigrated after 1995, the overall weighted seroprevalence of HBsAg was 2.3% [95% CI 1.5–3.5%], HCVAb 1.7% [1.0–2.9%], and TrpaAb 1.3% [0.7–2.3%]. No HIV cases were identified among the participants in the Maamu survey. (I)

Significant differences in seroprevalence of HBsAg, HCVAb and TrpaAb between Kurdish, Russian and Somali migrant populations were observed (Table 11). In general, Kurdish-origin migrants had low levels of infection and none of the Kurdish women tested positive for HBsAg, HCVAb, HIV or TrpaAb. As compared to the Kurdish migrant population, Somali-origin migrants had significantly higher HBsAg prevalence and Russian-origin migrants significantly higher TrpaAb seroprevalence. Russian women had significantly higher TrpaAb seroprevalence than men (4.5 vs. 0.6% respectively, p=0.04). (I)

Seroprevalence of HBsAg and TrpaAb were similar among all participants in the Maamu survey and all asylum seekers in Finland during 2015–2016. However, HBsAg seroprevalence among Somali-origin migrants in Maamu survey was significantly higher than observed among all asylum seekers (Table 11). (I, III)

Trends in seroprevalence varied with age for different infections and migrant populations despite of the sparsity of the data (Table 12). The overall weighted seroprevalence of HBsAg was not associated with age among all participants in the Maamu survey. HBsAg seroprevalence among the

youngest age cohort of 18–29 years was 1.8% [95% CI 0.8–4.0%], among the 30–44 year-olds 2.1% [1.0–4.3%], and among the 45–64 year-olds 3.4% [1.7–6.5%] (p=0.11 using age as a covariate). For Somali-origin migrants however, a statistically significant increase in HBsAg seroprevalence with age was observed (OR 1.05 by year, 95% CI 1.01–1.09). (I)

Table 11. *Seroprevalence of HBsAg, HCVAb, HIVAgAb and TrpaAb among adult Kurdish, Russian and Somali migrants who immigrated after 1995 and among all asylum seekers in Finland during 2015-2016; % [95% confidence interval] (crude n).*

	Maamu survey; %[a] [95% CI] (n[b])			**Asylum seekers; % [95% CI] (n) n_{tot}=38 134**
	Kurdish; n=415	**Russian; n=324**	**Somali; n=261**	
HBsAg[c]	0.4 [0.1–1.5] (2)	1.7 [0.7–4.3] (5)	6.0 [3.6–9.9] (16)	1.4 [1.3–1.6] (318)
HCVAb[c]	0.1 [0.0–0.5] (1)	4.1 [2.2–7.3] (12)	1.3 [0.4–4.1] (3)	NA
HIV-AgAb[d]	0	0	0	0.3 [0.1–0.4] (45)
TrpaAb[e]	0.3 [0.1–1.9] (1)	2.9 [1.5–5.6] (9)	1.0 [0.2–3.8] (2)	1.0 [0.8–1.1] (211)

[a]Population weighted seroprevalence; [b]Crude n; [c]p<0.01 between Maamu migrant groups; [d]p<0.05 between overall seroprevalence in Maamu survey and among asylum seekers; [e]p<0.05 between Maamu migrant groups; NA = Not available. Categories of hepatitis B endemicity: green=very low (<0.5%), yellow=low (<2%), orange=low-intermediate (2–4.99%), red=high-intermediate (5–7.99%) [55, 92]. Categories of hepatitis C endemicity: green=very low (<1%), yellow=low (1–2%), orange=intermediate (2–3%), red=high (3–5%) [120].

Conversely, the overall weighted seroprevalence of HCVAb and TrpaAb increased with age among all participants in the Maamu survey. HCVAb seroprevalence increased from 0.7% [95% CI 0.2–3.0%] among the youngest, to 1.5% [0.6–3.8%] among the middle, and finally to 3.5% [1.8–6.8%] among the oldest age group (p=0.01). After stratification with origin, increasing trend in HCVAb seroprevalence with age persisted among Kurdish (OR 1.07 by year, 95% CI 1.06–1.09) and Somali-origin migrants (1.16, 1.09–1.23) (Table 12). (I)

TrpaAb seroprevalence was 0.4% [0.1–2.1%] among the youngest, 1.2% [0.4–3.2%] among the middle, and 3.1% [1.5–6.4%] among the oldest age group (p<0.01). TrpaAb seroprevalence increased significantly with age among migrants of Russian (OR 1.04 by year, 95% CI 1.01–1.08) and Somali (1.27, 1.03–1.57) origin. In contrast, a decreasing trend with age in TrpaAb seroprevalence was observed among Kurdish migrants (0.84, 0.82–0.86). (Table 12) (I)

For asylum seekers, HBsAg seroprevalence was significantly higher among adolescents aged 16 to 17 years and adults in comparison to children under 16 years of age (Table 13). Adults had also higher HIV and TrpaAb seroprevalence rates in comparison to children. No cases of HIV were identified among asylum-seeking children less than 18 years of age. (III)

Table 12. *Population weighted[a] seroprevalence of HBsAg, HCVAb and TrpaAb in age groups[b] among Kurdish, Russian and Somali migrants; % [95% confidence interval] (crude n). Total n=1,000.*

	Kurdish (n=415)			**Russian (n=324)**			**Somali (n=261)**		
Age group (n)	**18–29 (141)**	**30–44 (193)**	**45–64 (81)**	**18–29 (92)**	**30–44 (111)**	**45–64 (121)**	**18–29 (123)**	**30–44 (85)**	**45–64 (53)**
HBsAg	0.4 [0.1–1.8] (1)	NA (0)	1.5 [0.2–8.6] (1), p=0.69	1.7 [0.2–11.1] (1)	2.1 [0.5–8.6] (2)	1.3 [0.3–5.1] (2), p=0.54	3.6 [1.4–9.1] (6)	6.4 [2.6–14.9] (5)	11.6 [4.9–25.0] (5), **p=0.01**
HCVAb	NA (0)	0.2 [0–1.2] (1)	NA (0), **p<0.01**	2.7 [0.7–10.7] (2)	5.1 [1.9–13.0] (4)	4.3 [1.8–9.5] (6), p=0.75	NA (0)	NA (0)	7.6 [2.5–21.1] (3), **p<0.01**
TrpaAb	0.9 [0.1–5.3] (1)	NA (0)	NA (0), **p<0.01**	NA(0)	4.3 [1.5–11.3] (4)	4.1 [1.7–9.6] (5), **p<0.01**	NA (0)	NA (0)	5.6 [1.4–19.7] (2), **p<0.01**

[a]Population weights developed according to age group, sex, migrant population, municipality and marital status; [b]p-values calculated using age as a continuous variable. Bolded values represent statistically significant differences. NA = Estimate not available. Categories of hepatitis B endemicity: green=very low (<0.5%), yellow=low (<2%), orange=low-intermediate (2–4.99%), red=high-intermediate (5–7.99%), purple=high (≥8%) [55, 92]. Categories of hepatitis C endemicity: green=very low (<1%), yellow=low (1–2%), orange=intermediate (2–3%), red=high (3–5%), purple=very high (>5%) [120].

Table 13. *Seroprevalence of chronic hepatitis B, HIV and syphilis among asylum seekers in age groups; % [95% confidence interval] (n).*

	0–6 years	**7–15 years**	**16–17 years**	**18 years or above**
HBsAg (n=22,144)	0.1 [0–0 .3] (2)	0.5 [0.2–0.8] (10)	1.7 [1.1–2.3] (32)[a]	1.6 [1.4–1.8] (274)[b]
HIVAgAb (n=13,768)	0.0 (0)	0.0 (0)	0.0 (0)	0.5 [0.3–0.6] (45)[a]
TrpaAb (n=22,016)	0.1 [0–0.2] (1)	0.1 [0–0.3] (3)	0.4 [0.1–0.7] (8)	1.2 [1.0–1.4] (199)[a,b]

[a]p<0.01 in comparison to younger age groups; [b]p<0.01 between children and adults. Categories of hepatitis B endemicity: green=very low (<0.5%), yellow=low (<2%) [55, 92].

5.3.2 BURDEN OF DISEASE (I)

Burden of hepatitis B and C, HIV and syphilis was estimated by extrapolating from the observed weighted seroprevalences in Maamu survey to the total adult Kurdish, Russian and Somali-origin first-generation migrant populations in Finland in the end of 2017 [30] (I). Russian migrants represented the largest migrant population followed by Kurdish and Somali-origin migrants (Table 14). Highest number of HBsAg, HCVAb and TrpaAb positive cases was estimated to occur among Russian-origin migrants. Burden of HIV could not be estimated as no cases of HIV were identified among participants in the Maamu survey.

Table 14. *Estimated burden of HBsAg, HCVAb and TrpaAb seroprevalence and missed diagnoses among 18 to 64-year-old Kurdish, Russian and Somali-origin migrant populations living in Finland on Dec 31, 2017 [30]; n [95% confidence interval].*

		Kurdish[a]	Russian[b]	Somali[c]
Total migrant population in Finland; aged 18 to 64 years		19,041	57,600	9,611
HBsAg	Total HBsAg-positive	76 [19–286]	979 [403–2,477]	577 [346–951]
	Missed HBsAg diagnoses	76 [19–286]	403 [115–1,267]	288 [135–586]
HCVAb	Total HCVAb-positive	19 [0–95]	2,362 [1,267–4,205]	125 [38–394]
	Missed HCVAb diagnoses	19 [0–95]	1,728 [864–3,398]	29 [0–183]
TrpaAb	Total TrpaAb-positive	57 [19–362]	1,670 [850–3,226]	96 [19–365]
	Missed TrpaAb diagnoses	57 [19–362]	1,382 [691–2,822]	96 [19–365]

[a]First-generation 18 to 64 year old migrants with a country of birth Iraq or Iran [30]; [b]First-generation 18 to 64 year old migrants with a country of birth Russia or Former Soviet Union [30]; [c]First-generation 18 to 64 year old migrants with a country of birth Somalia [30].

5.4 IMPLEMENTATION OF SCREENING

5.4.1 SCREENING COVERAGE (I, III, IV)

Coverage of infectious disease screening was assessed in publications I and III, and participation in previous HIV testing in publications I and IV.

Self-reported participation in infectious disease screening after arrival was assessed during Maamu survey health interview. Weighted coverage of infectious disease screening was 91.9% [95% CI 87.3–93.8%] among Kurdish, 49.2% [6.3–93.3%] among Russian and 81.4% [73.8–87.1%] among Somali-origin migrants who had immigrated as asylum seekers or refugees after 1995 (p=0.01 between groups), and the overall weighted coverage was 87.5% [83.9–90.3%]. No differences in self-reported weighted screening

coverage was observed between men and women (p=0.97) nor according to age (p=0.86). (I)

Coverage of infectious disease screening was assessed also among asylum seekers in Finland during 2015–2016 using syphilis screening as a proxy for any performed screening of any blood-borne and sexually transmitted infection (III). Of the 37,614 asylum seekers included in the study, 95.2% were eligible for the screening of CHB, HIV or syphilis based on country of origin. No difference in the eligibility for screening between children and adults was observed. The overall coverage of screening was 60.6% with 22,016 TrpaAb tests performed during 2015–2016. The screening coverage was 60.4% among eligible adults and 61.4% among eligible children (p=0.26 between age groups). (III)

One-third (31.4%) of participants in the Maamu survey reported previous HIV testing with significant differences between migrant populations of different origin (p<0.01) (Table 15) (I).

Table 15. *Proportion reporting previous HIV testing; % [95% confidence interval].*

Study population		Total	Women	Men	p[a]
Maamu	Kurdish migrants[b]	12.2 [9.5–15.5]	7.1 [4.4–11.4]	16.1 [12.0–21.3]	<0.01
	Russian migrants[b]	53.4 [47.4–59.3]	64.5 [57.1–71.3]	37.3 [28.3–47.3]	<0.01
	Somali migrants[b]	34.5 [28.5–41.1]	31.0 [23.8–39.1]	39.9 [29.5-51.2]	0.19
Asylum seekers in TIE survey		23.4	30.0	22.2	0.61
General population in WAD 2014 survey[b,c]		18.0 [14.9–21.7]	27.9 [22.9–33.4]	8.5 [5.3–13.4]	<0.01

[a]p between sexes; [b]Weighted prevalence; [c]Self-initiated HIV testing.

Women reported previous HIV testing more often than men both in Maamu survey and among the young adult general population in the WAD 2014 survey (Table 15). Overall weighted prevalence of previous HIV testing was 35.1% [95% CI 31.2–39.1%] among migrant women and 27.3% [23.2–31.9%] among migrant men in Maamu survey (p=0.01). In contrast, Kurdish men reported significantly higher rate of previous HIV testing in comparison to women. Age was not associated with previous HIV testing among participants in the Maamu survey (p=0.75). (I)

Among young adult asylum seekers in the TIE survey, no differences in previous HIV testing were observed according to gender or country of origin. Answering correct to all UNGASS indicator questions on HIV knowledge was borderline associated with previous HIV testing among participants to the TIE survey (p=0.09). (IV)

5.4.2 DELAY TO TEST AND MISSED DIAGNOSIS (I, III)

Delay to diagnosis or test and the number of missed diagnoses were evaluated in Maamu survey (I) and among all asylum seekers during 2015–2016 (III). Predictors of missed hepatitis B or C, or syphilis diagnosis were assessed in Maamu survey (I).

Of all seropositive findings in Maamu survey, one fifth (19.6%, n=11) had been notified to the NIDR within one year of immigration, two-fifths (39.3%, n=22) before the Maamu survey and 60.7% (n=34) did not have a prior notification in the NIDR and where thus considered missed diagnoses (Figure 5). The majority of hepatitis C and syphilis dignoses were notified over a year after immigration or diagnosed in the Maamu survey. Seven persons with TrpaAb-positive finding in Maamu survey had immigrated before 2005, when the reverse algorithm of syphilis testing and diagnosis with TrpaAb was widely implemented in Finland. (I)

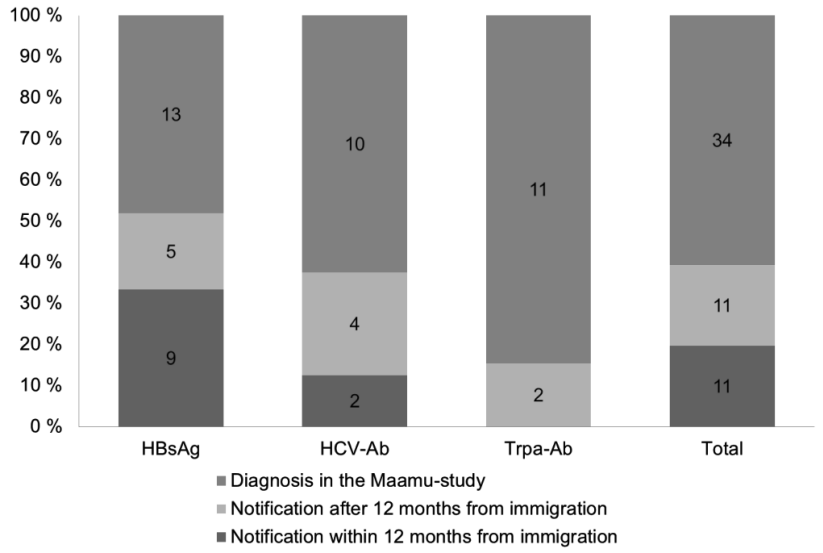

Figure 5 Timing of the diagnosis in relation to arrival; %. Numbers inside columns represent number of cases.

Missed diagnoses were identified among 33 individuals (3.3%) tested in the Maamu survey. Weighted prevalence of any missed diagnosis was 0.8% [95% CI 0.3–2.1%] among the Kurdish, 5.8% [3.6–9.2%] among the Russian and 4.2% [2.3–7.7%] among the Somali-origin migrants. Weighted prevalence of missed hepatitis B diagnosis was 3.0% [1.4–6.1%] among Somali-origin migrants. All diagnoses among Kurdish migrants had been missed. Extrapolating the prevalence of missed diagnosis to the total migrant populations in Finland, in total more than 4,000 diagnoses of CHB, HCVAb

or TrpaAb have been missed, the majority of these among Russian migrants (Table 14). (I)

In complex samples multivariate logistic regression, the risk for missed diagnosis was associated with Russian-origin (adjusted OR 7.74, 95% CI 1.55–38.75), marital status among the Somali-origin migrants (0.05, 0.01–0.36), daily smoking (3.71, 1.59–8.68) and self-reported previous blood-borne infectious disease diagnosis (9.00, 2.05–39.44) (I).

During 2015–2016, adult asylum seekers arrived in Finland earlier than children: the median date of asylum appeal was September 2015 for adults and October 2015 for children (Figure 6). Among screened adults, the estimated average delay from arrival to TrpaAb screening was 91 days, and 47 days for children. For adults, the blood screenings were delayed from the target time-frame from November 2015 until July 2016. For children, the blood screenings remained within the three-month target time frame throughout the follow-up period 2015–2016. (III)

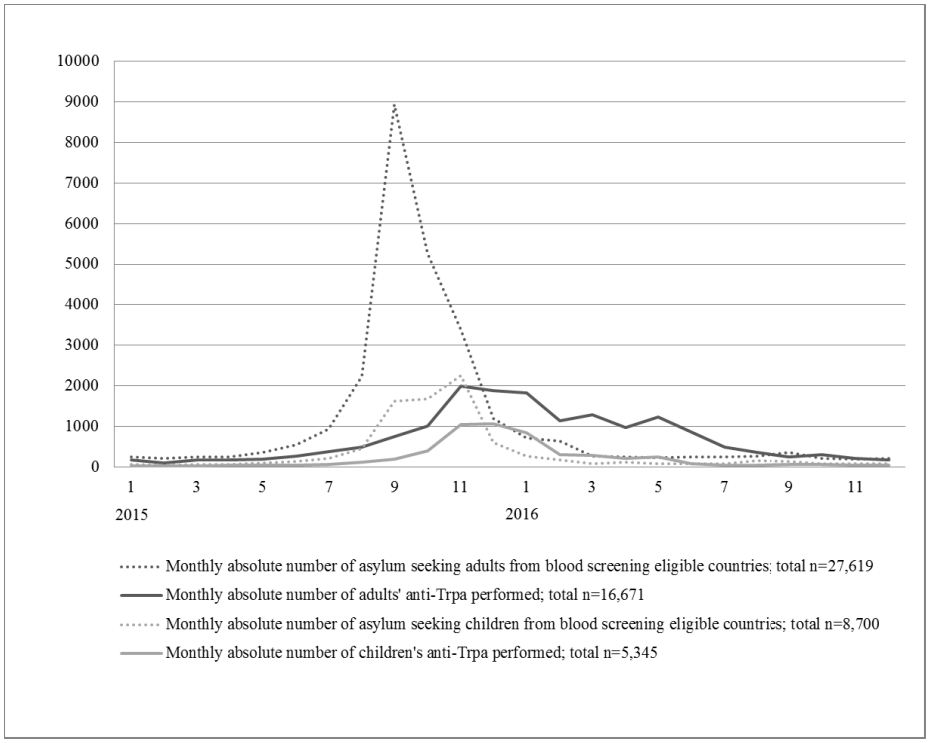

Figure 6 Numbers of arrived of asylum-seeking adults and children from blood-screening eligible countries, and number of TrpaAb screenings performed for adults and children by month in 2015–2016.

Based on the screening coverage and the observed seroprevalence rates, approximately 194 [95% CI 180–222] hepatitis B diagnoses, 42 [10–55] HIV

diagnoses and 139 [111–152] TrpaAb-positive cases were missed among the asylum seekers to Finland in 2015–2016. (III)

5.5 HIV RELATED KNOWLEDGE, ATTITUDES AND PRACTICES (IV)

TIE survey involved 68 participants, of whom all 47 individuals between 20 to 25 years of age were included in the analyses. Similarly, of the 1,011 participants in the WAD 2014 survey, all 485 aged between 20 to 25 years were included in the study.

Among asylum seekers, SSA origin, female gender and higher education were associated with better knowledge. Asylum seekers of SSA origin had higher UNGASS composite score in comparison to other regions of origin ($p<0.01$). Female asylum seekers had a borderline higher UNGASS composite score ($p=0.05$) and a higher proportion knew that HIV cannot be transmitted by sharing a meal (UNGASS 5) as compared to men ($p<0.05$). Asylum seekers with secondary education were more knowledgeable regarding benefits of condom use (UNGASS 2) in comparison to persons with lower education ($p<0.01$).

HIV-related KAP was compared between young asylum seekers in the TIE survey and young adult general population in the WAD 2014 survey. The UNGASS composite score representing a measure of comprehensive HIV KAP, was significantly lower among the young asylum seekers in comparison to young adult general population (6.4 vs. 50.3% respectively, $p<0.05$) (Table 16).

In general, young adult asylum seekers had more gaps in specific questions related to HIV knowledge as compared to general population young adults. The differences between populations predominantly persisted after stratification by gender and level of education. However, among highly educated men, the gaps disappeared with respect to knowledge that risk of HIV transmission can be reduced by using a condom (UNGASS 2) and that HIV cannot transmit through kissing.

Attitudes to HIV were equally supportive among young asylum seekers and young adult general population. Of the young asylum seekers, 45.7% [95% CI 28.9–62.1%] would support a friend living with HIV and 58.8% [54.0–63.4%] of the general population young adults would do as well. No differences in attitudes related to HIV were observed between sexes or levels of education.

Young adults were asked about their preferred sources of HIV-related information. Young adult asylum seekers named television (59.6%, 95% CI 46.2–74.5%), the internet (53.2%, 38.8–67.4%) and health workers (46.8%, 33.3–60.9%) as the three most popular sources of information, with no significant gender differences. Among the general population, the most popular sources of information were school nurse (75.4%, 71.0–79.3%),

parents (51.6%, 46.8–56.3%) and events organized at schools (47.5%, 42.7–52.2%). General population women preferred health education by parents and through school events as compared to men ($p<0.05$ and <0.01 respectively). For general young adult population men, teachers were the third most popular source of information on sexual health and HIV (48.1%, 40.6–55.6%).

Table 16. *HIV knowledge, attitudes and practices among young asylum seekers (TIE survey) and young adult general population (WAD 2014 survey). Mean %; 95% confidence interval, p between groups.*

	TIE survey	WAD 2014 survey	p
KNOWLEDGE			
UNGASS composite score (indicators 2-5)	6.4 [0–14.0]	50.3 [45.5–55.1]	<0.05
Risk of HIV transmission can be reduced by using a condom (UNGASS 2)	59.0 [43.9–74.4]	87.5 [85.2–89.5]	<0.05
A healthy looking person can have HIV (UNGASS 3)	31.0 [17.8–45.2]	99.1 [97.9–99.6]	<0.05
A person cannot get HIV from mosquito bites (UNGASS 4)	26.8 [13.5–42.5]	56.3 [53.0–59.7]	<0.05
A person cannot get HIV by sharing a meal with someone who is infected (UNGASS 5)	38.1 [23.4–55.3]	88 [85.6–90.0]	<0.05
HIV can be treated	26.8 [13.6–42.1]	83 [77.0–87.7]	<0.05
A person cannot get HIV through kissing	42.9 [28.2–57.8]	83.4 [77.4–88.2]	<0.05
ATTITUDES			
Supportive reaction to HIV positivity	45.7 [28.9–62.1]	58.8 [54–63.4]	>0.05

HIV related practices were assessed by assessing participation in previous HIV testing. The results are presented in chapter 5.4.1 “Screening coverage”.

6 DISCUSSION

This study showed that migrant populations in Finland are heterogeneous with respect to seroprevalence of hepatitis B and C, HIV and syphilis. Some migrants are especially vulnerable to blood-borne and sexually transmitted infectious: they have higher seroprevalence rates in comparison to the general population and a substantial proportion of the infections are undiagnosed. This study identified barriers and opportunities for prevention and early diagnosis of blood-borne and sexually transmitted infections among migrants. Poor knowledge about transmission, prevention and treatment of infections might encourage risk behaviours and delay testing. Current screening guidelines do not target all migrants at increased risk. Furthermore, they are not implemented efficiently and coverage of screening among migrants is suboptimal. As provider-initiated testing is well-accepted among migrants, healthcare providers should not miss opportunities to offer testing.

6.1 FEASIBILITY OF TESTING IN POPULATION HEALTH SURVEYS

Maamu survey was the first population-based health survey in Finland to include infectious disease screening and, to the best of our knowledge, the first survey globally to assess non-participation based on history of infectious diseases. The non-participation analysis demonstrated that the participants and non-participants in the Maamu survey did not differ from each other as evaluated by previous notification prevalence of hepatitis B or C, HIV or syphilis. The finding implies that with respect to prevalence of infectious diseases, results from the Maamu survey are externally valid and generalizable to the total migrant population in Finland. (I)

Incidence of chronic and often asymptomatic infectious diseases such as CHB, CHC, HIV and syphilis reflects testing patterns more than it does actual incidence of infections [95]. Hence, reports of screening yields are valuable in establishing prevalence of infections in asymptomatic populations.

Migrant population-based surveys assessing infectious disease prevalence in general migrant population are sparse [140, 329]. Whole population analyses of infectious disease prevalence are available among selected groups of migrants such as asylum seekers and refugees but tend to over- or underestimate the prevalence in general populations through selection bias [94, 160].

Population-based health surveys provide an invaluable asset in estimating the disease burden among general populations. Prevalence of infections

among at-risk populations such as PWID, prisoners, MSM, paid blood donors, health service users or refugees might overestimate the prevalence as compared to the general populations, and hence prevalence studies among these populations are often excluded from reviews and meta-analyses [96, 103, 118, 119, 147]. Voluntary blood donors have usually lower burden of infections than the general population due to pre-selection [41]. ANS yields describe the prevalence of infections among fertile women, but represent often the best guess of seroprevalence among the general population [147].

Acceptability of the provider-initiated opt-in multiphasic hepatitis B and C, HIV and syphilis screening was high among all migrant populations in the Maamu survey and similar or higher than in most other surveys among migrant populations [142, 208, 256, 264, 303, 304, 324] . In Maamu survey, screening for was accepted better by women in comparison to men. (I, II) Previous studies have found migrant women to have higher acceptance rates as compared to men partially owing to increased exposure to testing in universal opt-out ANS settings [142, 207, 288]. However, in a British cross-sectional study among clients of a sexual health clinic, migrant and ethnic minority men had higher acceptability of HIV testing in comparison to women, which led the authors to speculate that women's increased exposure to testing in ANS and other settings might actually increase the refusal rate [400].

Association of acceptability of testing with determinants of migrants' lower socio-economic status such as unemployment and poor language skills might reflect migrants self-perceived infectious disease risks, patterns of trust towards health providers or unmet demand for health services (II). An opposite observation was made in a UK study among clients of sexual health clinics where risk for refusal of HIV testing was higher for migrants living in deprived areas [400]. Additionally, other studies have found increased acceptability of HIV testing among migrants to associate with MSM, increased risk behaviour, rapid testing, testing in primary care or in community settings [142, 207, 208, 400]. A review among general population in the UK concluded that HIV testing uptake was higher among symptomatic than asymptomatic individuals [401].

Acceptability of opt-in HIV testing was significantly improved by enhanced pre-test counselling adopted after findings from the pilot survey (II). Although opt-in PITC strategies have been demonstrated high acceptability among migrants, recently several guidelines recommend provider-initiated routine or opt-out strategies to further increase HIV testing coverage [138, 402]. As acceptability of testing influences the effectiveness of screening interventions, health professional should be trained in negotiating testing especially with persons without apparent risk-factors [208].

The moral principle of reciprocity can be used to explain acceptability of screening and to justify screening programmes. The expectations and benefits of the individual and the public meet when an individual's losses for participation in infectious disease screening are compensated by benefits gained from access to health services, for example. [277] The reciprocity

principle might thus explain why, as an example, forced migrants have previously been reported to have higher acceptance rates of infectious disease screening in comparison to other migrant populations [208].

Finally, high acceptability of testing in the Maamu survey supports inclusion of infectious disease screening in future population health surveys.

6.2 SEROPREVALENCE AND BURDEN OF DISEASE

6.2.1 HEPATITIS B

HBsAg seroprevalence rates differed among included migrant populations in the Maamu survey. Very low (<0.5%) HBsAg seroprevalence was observed among Kurdish migrants, low (<2%) seroprevalence among Russian migrants and high-intermediate (5–7.99%) seroprevalence among Somali-origin migrants (Table 11). (I) HBsAg seroprevalence rate among the total asylum-seeker population was low (<2%, III). As compared to the estimated Finnish general population HBsAg seroprevalence of <0.2%, HBsAg seroprevalence was higher among Russian (1.7%) and Somali (6.0%) origin migrants, and among asylum seekers (1.4%) (I, III).

The observed HBsAg seroprevalence rates among Kurdish, Russian and Somali-origin migrants were comparable or lower than observed in previous research in countries of origin and among migrants in high-income countries [40, 96, 97, 102, 107] (Tables 1 and 11) (I).

Similarly, HBsAg seroprevalence among asylum seekers in Finland was comparable or lower than in previous seroprevalence studies among asylum seekers and refugees in Europe during the migrant crisis. These studies have reported HBsAg seroprevalence rates between 0.7–12.2% [150, 158, 160, 294, 324, 336, 337, 339-343, 401, 403]. The majority of HBsAg seroprevalence studies among asylum seekers included general populations [158, 160, 294, 336, 337, 339, 342, 343, 401]; some were conducted in healthcare settings [324, 340, 341, 403]; and few included only children [342, 343].

Previous research has found HBsAg seroprevalence among asylum seekers to mirror that of the countries of origin: higher rates have been observed among SSA-origin asylum seekers and lower rates among persons originating from the Middle East and North Africa [158, 294, 324, 336, 339-341, 403]. Almost 90% of the asylum seekers to Finland during 2015–2016 originated from Middle East and North Africa including Afghanistan, which is likely to explain the relatively low HBsAg prevalence observed as compared to reports from other European countries (III).

Selective migration of healthy individuals – the so-called healthy migrant phenomenon – could explain the comparable or lower HBsAg seroprevalence rates among migrants of Kurdish, Russian and Somali origin and among asylum seekers in Finland as compared to previous reports [6]. Moreover, the

results suggest that HBsAg seroprevalence rates reported previously among in-country populations and migrants can be used to estimate the HBV burden among migrant populations in Finland.

HBsAg seroprevalence rates increased with age among Somali-origin adult migrants and among asylum seekers (Tables 12 and 13) (I, III). Of note is that the strength of the prediction is compromised due to sparsity of the data. Increasing HBsAg seroprevalence with age was observed among asylum seekers in Germany also [403]. These observations are somewhat contradictory to findings from a systematic review and a meta-analysis on global age-specific HBsAg seroprevalence. Ott et al. observed decreasing HBsAg seroprevalence with age in Eastern and Sub-Saharan Africa and Middle East and North Africa both in 1990 and in 2005. [103] Considering that universal HBV vaccination program in Somalia has only been available since 2013 and previous studies have observed low coverage of HBV vaccine among Somali-origin migrants, the increasing HBsAg seroprevalence with age could suggest transmission in adulthood and possibly post-migration [294, 345].

During 1990–2005, the global HBsAg seroprevalence rates in the young age groups decreased, reflecting implementation of universal HBV immunization programs [103]. Indeed, the significantly lower HBsAg seroprevalence in asylum-seeking children as compared to asylum-seeking adults or adult Kurdish, Russian and Somali-origin migrants might reflect implementation of universal childhood HBV vaccination in the countries of origin [345]. The higher HBsAg seroprevalence among 16–17 year old asylum seekers in comparison to younger children can partly be explained by misreporting of age. Approximately every sixth of unaccompanied minor asylum seekers in Finland during 2015–2016 has later been deemed over 18 years of age [404]. The implementation of universal HBV vaccination programs in migrants' countries of origin is likely to influence the epidemiology of hepatitis B among migrants in Finland in the future [57, 345].

Considering evidence from previous systematic reviews that support of CHB screening in populations with HBsAg prevalence as low as 0.3%, selective screening of CHB among Kurdish, Russian and Somali-origin migrants is likely to be cost-effective [41, 208, 276]. Of note, however, is that cost-effectiveness of screening depends greatly on the operational effectiveness of screening (Figure 2) [208].

The burden of hepatitis B was estimated by extrapolating population prevalence to the size of the migrant population. As migrants born in Russia or the FSU represent the largest migrant population in Finland, Russian-origin migrants had also the largest hepatitis B burden despite having low HBsAg seroprevalence (Table 14) (I) [30]. Migrants of Somali origin also had a substantial number of hepatitis B infections.

Keeping in mind that the vast majority of Russian-origin migrants in Finland are not refugees, they fall outside current hepatitis B screening recommendations for asylum seekers and refugees [272, 376]. Municipalities offer health examinations for refugees, asylum seekers and other migrants

with permanent residency and in need of integration and employment services. [269] Labour migrants, students and family members with migrant origin are encountered unsystematically in occupational healthcare, student healthcare and in ANS. Furthermore, Russian-origin migrants use parallel healthcare services in countries of origin and may thus avoid screening in Finland [226]. Indeed, Karvonen et al. have estimated that the current hepatitis B screening guidelines fail to catch more than two-thirds of the migrants with CHB immigrating to Finland annually [57, 272].

Finally, the observed HBsAg seroprevalence rates and burden of hepatitis B suggest that in the presence of targeted HBV vaccination programme in Finland, screening of hepatitis B is essential in identifying persons at risk who would benefit from vaccination.

6.2.2 HEPATITIS C

Seroprevalence of HCVAb was very low (<1%) among Kurdish migrants, low (1–2%) among Somali migrants and high (3–5%) among Russian-origin migrants (I). In comparison to the estimated general population HCV prevalence in Finland (0.3%), both Russian and Somali-origin migrants had higher HCVAb seroprevalence (4.1% and 1.3% respectively) [124].

The observed HCVAb seroprevalence rates among Kurdish and Russian-origin migrants were similar as previously reported among general populations in countries of origin and among migrants in high-income countries [39, 119] (Tables 1 and 11) (I). Mohd Hanafiah et al. estimated a comparable overall HCVAb seroprevalence of 2.9% in the FSU countries [118]. WHO presented a comparable HCVAb prevalence estimate of 0.9% for Iran and 3.2% for Iraq in 1999 [120, 363].

Previous studies among asylum seekers and refugees in Europe during the migrant crisis have found HCVAb seroprevalences to range between 0–6% [150, 160, 294, 324, 338-341, 401, 403]. Most of the studies included general asylum seeker populations [160, 294, 338, 339, 401] and some were conducted in healthcare settings [324, 340, 341, 403]. In Italy, HCVAb seropositivity was reported especially among asylum seekers and refugees from Eastern Europe, India and Pakistan [340].

An increasing trend of HCVAb seroprevalence with age was observed among Kurdish and Somali-origin migrants that could be explained by prolonged time of exposure and accumulation of risk factors for transmission (Table 12) (I). Among Russian-origin migrants, HCVAb seroprevalence was not associated with age. The estimates are, however, vulnerable to uncertainties due to sparse data. Previously, older age has been observed as a predictor of HCVAb seropositivity among migrants and refugees [120, 403].

Systematic reviews have concluded that selective screening of hepatitis C among migrants from intermediate and high HCV prevalence areas (HCVAb prevalence >2%) is cost-effective. However, as migrant-population-specific assessments of HCVAb screening cost-effectiveness were sparse, HCVAb

screening is likely to be cost-effective also at lower population seroprevalence thresholds. [41, 208, 301]

Considering the observed HCVAb seroprevalence rates, implementation of HCV screening among Russian-origin migrants in Finland is likely to be cost-efficient (I). Cost-effectiveness of HCVAb screening among Somali-origin migrants should be evaluated. Cost-effectiveness of HCV screening among migrants is influenced by the operational effectiveness of the programme and, especially in case of HCV, drug prices (Figure 2) [208].

As migrants born in Russia or the FSU represent the largest migrant population in Finland, the burden of hepatitis C was also largest among migrants with Russian origin (Table 14) (I) [30]. Considering an approximate rate of 75% of viremic infection of all HCVAb-positive findings, Kurdish, Russian and Somali-origin migrants represent approximately one-tenth of CHC infections in Finland [60, 64, 223].

Currently Finnish national guidelines do not address HCV testing among migrants. Finnish national HCV strategy suggests implementation of HCV screening among asylum seekers from high-prevalence countries [223]. ECDC guidelines, on the other hand, support HCV testing among migrants from HCV-endemic areas (prevalence >2%) [36]. The substantial burden of HCV observed among Russian origin migrants implies that in case HCV screening among migrants is to be adopted in Finland in the future, screening recommendations should consider strategies to reach labour migrants, students and migrant family members.

6.2.3 HIV

No cases of HIV infection were identified among Kurdish, Russian and Somali-origin migrants, which can be explained by the relatively low HIV prevalence in countries of origin and the number of individuals screened in the Maamu survey. According to UNAIDS estimates for 2017, the prevalence of HIV among adult population in Iran was 0.1%, in Somalia 0.1%, in Russia 1.2% and 0.8% in Eastern Europe and Central Asia [133, 135]. Also, selective migration of healthy individuals might play a role [6].

Overall HIV seroprevalence among all asylum seekers was at low level (<1%, III), and comparable or lower than in previous studies among asylum seekers in Europe during the migrant crisis, when 0–4% HIV seroprevalence rates were observed [150, 158, 160, 324, 336, 339-341, 401, 403, 405, 406]. Most of these studies included general asylum seeker populations [158, 160, 336, 339, 401, 405, 406] and some were conducted in healthcare settings [324, 340, 341, 403]. Previously, higher HIV prevalence has been observed among asylum seekers from SSA and Eastern Europe in comparison to other regions of origin [324, 339, 340].

Evidence of cost-effectiveness of HIV testing among migrants in the EU/EEA is scarce [300, 407]. ECDC has recommended HIV screening among migrants from areas with generalized epidemics (prevalence >1%) and among those at increased risk for exposure to HIV [36]. Finland implements

the ECDC guideline among refugees and asylum seekers [272]. Finnish national HIV strategy suggests expanding HIV screening also to migrant populations beyond refugees and asylum seekers [145]. Results from this study support continuation of HIV screening among asylum seekers. For other migrant populations – such as for Russian-origin migrants – strategies to reach at-risk migrants in Finland should be evaluated.

6.2.4 SYPHILIS

TrpaAb seropositivity affected especially Russian and Somali-origin migrants. TrpaAb seroprevalence was higher among Russian-origin migrants than among the Finnish general population (2.9 vs. 0.11% respectively). (I) Both Somali-origin migrants and asylum seekers appeared to have comparable or higher TrpaAb seroprevalence than the general population in Finland (I, III). TrpaAb seroprevalence among Kurdish-origin migrants was similar to the general population in Finland (I).

According to WHO, the prevalence of positive syphilis serology in antenatal care was 0% in Iran (2017) and Iraq (2010), and 1.4% in Somalia (2017) [408]. Rates are comparable to the ones observed in Maamu survey (I). For Russian origin migrants, the observed TrpaAb seroprevalence rates seem higher than observed in previous literature. However, no recent data on syphilis prevalence among the general population seems to be available. In a review by Kenyon et al. a syphilis prevalence of 0-0.5% in Russia during 1990–1999 is presented mainly based on ANS data [148]. The Global Burden of Diseases study modelled a syphilis prevalence in Russia 0.18% in 2012 [98].

TrpaAb seroprevalence rate among overall asylum seeker population was low (<1%, III), and comparable or lower than in previous publications among asylum seekers and refugees in Europe during the migrant crisis. Previous studies have observed 0.1–3.8% of asylum seekers to have positive syphilis serology [150, 160, 324, 339, 401, 405]. The majority of the studies included general asylum seeker populations [160, 339, 401, 405] and one was conducted in a healthcare setting [324].

TrpaAb seroprevalence increased with age among Russian and Somali-origin migrant populations in the Maamu survey and among asylum seekers. Among Kurdish migrants, TrpaAb seroprevalence seemed to decrease with age. (Tables 12 and 13) (I, III) While interpreting the results, it's important to keep in mind the limits of sparse data especially among Kurdish migrants. Increasing TrpaAb seroprevalence rates with age can be explained by prolonged time of exposure and accumulation of risk factors for transmission. Previously, increased age has been observed as a predictor of syphilis seropositivity among refugees [151].

Syphilis notification incidence increased significantly in FSU countries with the dissolution of the Soviet Union in 1991 followed by a decrease in governmental healthcare investments, marginalization of especially women

and emergence of HIV epidemic, and was reflected in Finland also [154, 409, 410]. As we included migrants that had immigrated to Finland after 1995, the majority of Russian-origin participants in Maamu survey have lived in Russia during this syphilis epidemic. Contrasting to the observation of higher syphilis seroprevalence in the Maamu survey among Russian-origin women compared to men, notification rate of syphilis in Russia during 1985–1996 showed no gender difference [410]. (I)

The burden of syphilis affected Russian-origin migrants especially, the largest migrant population in Finland (Table 14) (I). Current syphilis screening guidelines among asylum seekers and refugees cannot target this burden as the majority of migrants from Russia and the FSU have immigrated for employment, studies or for family reasons [272, 376]. Furthermore, as TrpaAb seroprevalence was highest among persons over 30 years of age, universal ANS might not address this burden.

Syphilis was not considered as a key infectious disease among migrants in Europe by the ECDC ad hoc scientific panel and hence effectiveness and cost-effectiveness of syphilis screening among migrants in EU/EEA was not systematically assessed [36]. This study contributes for the evidence that some migrant populations are especially vulnerable to syphilis and that targeted screening strategies should be considered [280].

6.3 IMPLEMENTATION OF SCREENING

The results from publications I and III suggest that there are difficulties in implementing the national infectious disease screening guidelines [272]. The overall screening coverage of hepatitis B and C, HIV and syphilis among eligible asylum seekers to Finland during 2015–2016 (60.6%, III) was lower than the self-reported coverage of infectious screening after arrival among resident Kurdish, Russian and Somali-origin migrants who had immigrated as refugees or asylum seekers after 1995 (87.5%, I). The lower coverage among asylum seekers can be explained partly by difficulties in scaling up the service provision during the large influx of asylum seekers in fall 2015, and by the emergence of regional austerity measures that restricted screening services [397, 411].

Upon granting of asylum and residency in Finland, the responsibility for infectious disease screening is transferred from the immigration authorities to the municipalities. Most municipalities offer health examinations for newly arrived refugees and asylum seekers. Labour migrants are usually not targeted unless they are in need of integration and employment services. [269] Labour migrants, students and family members with migrant origin are met unsystematically through occupational healthcare, student healthcare and ANS. During these health examinations, infectious disease screening is offered for those who haven't been screened during the asylum process. This double-check can explain the better coverage among resident migrants

compared to asylum seekers. Nevertheless, poor screening coverage may allow the spread of infections among persons not linked to care and jeopardizes the cost-effectiveness of screening (Figure 2) [208, 280].

Suboptimal infectious disease screening coverage among migrants was also observed in a recent systematic review, where the coverage ranged from 14.5–92.5%, and 0.12–79.0% of migrants did not complete screening. Based on the findings, Seedat et al. conclude that while selective screening of infectious diseases seems to be acceptable among migrants, more emphasis needs to be put on engaging migrants in screening and linkage-to-care in order to improve screening effectiveness and cost-effectiveness. Furthermore, the evidence base for evaluating the operational effectiveness of infectious disease screening among migrant populations in EU/EEA needs to be strengthened. [208] In Finland, operational effectiveness of infectious disease screening among migrants is not systematically monitored [274].

Previous HIV testing was reported by 13–53% of the resident Kurdish, Russian and Somali resident migrants and asylum seekers (I, III, IV), and by 18% of young adult general population in Finland (IV). As observed, women tend to have higher HIV testing rates due to usage of SRH services [88, 207, 210]. The lower rate of previous self-reported HIV testing among Kurdish migrants can be explained by the national guidelines that do not recommend HIV testing for asylum seekers and refugees originating from Iran and Iraq [311]. However, the low rates of self-reported testing among migrants in general suggest that some might not acknowledge having participated in screening and that opportunities for pre-test counselling, health education and prevention have been missed.

As opposed to previous studies, older age was not associated with higher HIV testing rates in the Maamu survey (I) [210]. Borderline association of participation to previous HIV testing among those asylum seekers more knowledgeable on HIV implies that increased knowledge may increase HIV testing frequency, and this is supported by previous literature (IV) [207, 210]. Interestingly, self-reported HIV testing rates among migrants were significantly lower than in a recent cross-sectional multicentre survey that applied convenience sampling in nine European countries, suggesting possible lower availability of testing for migrants in Finland compared to other EU countries [207].

Several delays from immigration to screening and diagnosis were observed among resident migrants (I) and asylum seekers (III). Only one-fifth of diagnoses in the Maamu survey had been diagnosed and notified within one year after immigration. The burden of missed diagnoses was largest among Russian migrants not targeted by the current national screening guidelines (Table 14) [226, 272]. Furthermore, the substantial prevalence of missed hepatitis B diagnoses among Somali-origin migrants, the majority of whom had immigrated as refugees or asylum seekers and hence should have been offered screening upon arrival, suggests either suboptimal coverage of screening after arrival or low hepatitis B vaccination

coverage resulting in infections post-migration (I). These results add to the evidence that migrants use primary health services frequently in particular, but opportunities for PITC and diagnosis are being missed [207, 209].

The association of missed diagnoses and self-reported previous diagnosis of a blood-borne infection suggests that migrants might have been diagnosed previously in a country other than Finland (I). However, unless a diagnosis is confirmed in Finland, migrants are not likely to be followed-up for their infection. Among Somali-origin migrants, living in a permanent relationship protected from missed diagnosis, which could translate to safer sexual practices (I). Daily smoking, on the other hand, was associated with increased risk for missed diagnosis and could reflect health-seeking behaviours (I).

Gender was not a significant predictor of missed diagnosis. The observed delays from immigration to diagnosis were longer than reported among HIV-positive migrant women attending ANS in Finland, adding to the evidence of the benefits of universal screening in ANS [146]. Similarly, in France, a study reported a median delay from immigration to CHB diagnosis of four years for men and two years for women, with more women being diagnosed through systematic screening such as ANS [321]. Another study involving the same subjects concluded a delay from immigration to HIV testing of two years both among migrant men and women attending primary healthcare [216].

Timing of screening for blood-borne and sexually transmitted diseases during a large influx of refugees has not been previously described. A study from Sweden approximated a delay of five months from immigration to referral for TB assessment [341]. The observed longer delay to screening among adults as compared to children suggests that children as a vulnerable population were prioritized in health services (III).

To summarize, the observations regarding the implementation of infectious disease screening in Finland imply that the coverage of the multiphasic screening according to national guidelines is suboptimal, there are delays from immigration to screening and diagnosis, and the uptake of HIV testing might be at lower level in comparison to other EU countries (I, III, IV). Hepatitis B vaccination coverage among VFR travellers and family members of CHB patients might be insufficient to prevent infections after immigration. Additionally, migrant populations other than refugees and asylum seekers are not reached by current screening recommendations. In order to increase the effectiveness and cost-effectiveness of screening among migrants, these issues should be addressed [208].

The most beneficial screening strategies consider the heterogeneity of the migrant populations and the relative contributions of migrants to the overall epidemics of hepatitis B and C, HIV and syphilis [39, 40, 142]. In order to reach all infected, most likely several parallel tailored strategies such as systematic and opportunistic screening and outreach services are needed. Potential approaches include exploiting and broadening existing approaches such as ANS to include fathers, extending screening after arrival to migrant

populations other than refugees and asylum seekers, applying multiphasic testing, and ensuring the coverage, uptake and continuum of care as well as reasonable prices of drugs alongside the screening trajectory (Figure 2) [41, 88, 208, 223, 407]. Previously, approaches for CHB and HCV screening among migrants have been summarized by the HEPscreen consortium [412]. The national ANS working group has suggested evaluation of effectiveness of antenatal hepatitis C screening [88].

6.4 HEALTH LITERACY

Both young adult asylum seekers and the young adult general population in Finland had important gaps in HIV-related knowledge that might increase risk behaviour and delay testing and diagnosis. The gaps were especially pronounced among young asylum seekers. UNGASS composite score was below the international target of 95% for both populations [249]. (IV)

In 2005–2016 UNGASS reports, Algeria, Egypt, Eritrea, Finland, Iraq, Russia, Saudi-Arabia, Somalia and Syria did not report data on HIV KAP among young people. For 2016, data were available for Cameroon, Ethiopia, Gambia, Iran, Morocco and Nigeria, where 18.3–63.2% of young people aged 15 to 24 years were knowledgeable about HIV, based on UNGASS composite score. [413] The reported rates from SSA countries support our observation that better HIV knowledge was associated with SSA origin among young asylum seekers to Finland (IV). Migrant regions of origin with generalized HIV epidemics, such as SSA, may explain previous exposure to preventive messages and better performance in knowledge assessment.

In addition to region of origin, previous studies have consistently observed higher HIV and STI knowledge among migrants to be associated with higher educational status [251, 253-255, 257]. Furthermore, previous studies have shown contradictory effects of age and gender with HIV knowledge [251, 253, 255, 256]. In the TIE survey, better knowledge was associated with higher education and female gender. However, the majority of young asylum seekers were male, less educated and had low levels of HIV-related knowledge compared to the general population making them vulnerable to HIV. (IV)

SRH knowledge among secondary school, vocational school and high school students in Finland has decreased between 2008 and 2013 [270]. Both first and second-generation migrant-origin adolescents are known to have lower SRH knowledge in comparison to Finnish origin adolescents [414]. Young girls have been consistently more knowledgeable than boys [270]. Differences among migrant and Finnish-origin adolescents were explained by parents' socio-economic background and by cultural differences in how SRH issues are discussed in families [414].

Passive sources of HIV information were preferred by young adult asylum seekers as opposed to interpersonal strategies preferred by the general population young adults in our study (IV). Healthcare workers have an

important role in HIV information delivery for young asylum seekers. Curriculum-based SRH education in schools is recognized as being influential both among young people and service providers [270]. Acknowledging the preferred sources of HIV information might increase the acceptability of SRH education among adolescents and young adults with different migration backgrounds [280].

6.5 SUMMARY OF FINDINGS

Migrants represent a key population for the prevention and control of hepatitis B and C, HIV and syphilis epidemics in Finland. Migrants are vulnerable to infections pre- and post-migration and bear a disproportionate burden of disease. Data from current epidemiological surveillance are inadequate for the development of evidence-informed public health policies. This study describes the burden of infections among migrants of Kurdish, Russian and Somali origin and among asylum seekers in Finland, identifies gaps in prevention and suggests possible actions for public health response.

Population-based surveys are suitable for evaluation of infectious disease prevalence and risk factors. Results from the study demonstrate that previous diagnosis of hepatitis B or C, HIV or syphilis did not influence participation in the migrant population-based survey (I). A high acceptability of provider-initiated opt-in multiphasic hepatitis B/C/HIV/syphilis screening was achieved through enhanced pre-test counselling. Screening offers were especially accepted by individuals with lower socio-economic status. (I, II)

Seroprevalence of hepatitis B and C, HIV and syphilis differed among the study populations but were in general lower or comparable with reports from countries of origin as well as among migrants and asylum seekers in other high-income, low-prevalence countries (I, III). Kurdish migrants had low levels of infections (I). Russian-origin adult migrants, the largest migrant population in Finland, had a substantial burden of hepatitis C and syphilis. Somali-origin migrants were especially vulnerable to hepatitis B. Screening of asylum seekers yielded low levels of hepatitis B, HIV and syphilis infections.

Lower or comparable seroprevalence rates suggest selective migration of healthy individuals: the so-called healthy migrant phenomenon. Moreover, the observed low seroprevalence rates imply that access to care of hepatitis B and C, HIV or syphilis in Finland does not serve as a pull factor for migration. The results support the use of available in-country seroprevalence estimates in assessing the burden of hepatitis B and C, HIV and syphilis burden among other migrant populations.

Screening coverage of the migrant populations included in this study was suboptimal, which might endanger the effectiveness of the screening

programme. Repeated health examinations during the asylum process and after receiving residency increase the screening coverage among resident migrants. The asylum process is as a window of opportunity for infectious disease prevention and early diagnosis. (I, III)

Previous HIV testing was reported by fewer than a third of all migrants and general population young adults, despite these being key populations for STI prevention (I, IV). For chronic and often asymptomatic infections such as hepatitis B and C, HIV and syphilis, screening is the key for early diagnosis, treatment and success of secondary prevention. Both migrant and general population young adult women reported more testing, highlighting the success of opt-out provider-initiated universal screening in ANS and SRH service contexts. Men and fathers could also be reached through existing structures such as the ANS.

Current screening strategies have failed to diagnose more than half of the cases of hepatitis B and C and syphilis among resident Kurdish, Russian and Somali-origin adult migrants in Finland (I). Missed diagnoses imply missed opportunities for early diagnosis, treatment and prevention. Missed diagnoses increase morbidity among undiagnosed patients and have negative impacts also for society and communities, including higher healthcare costs related to late diagnosis and disease complications, and the risk of further transmission of infections. The highest proportion of missed diagnoses was observed among Russian-origin migrants not targeted by the current screening guidelines. Missed hepatitis B diagnoses among Somali-origin migrants suggest low coverage of protective immunity and infections post-migration.

To assess the effectiveness of infectious disease screening among migrants, data on relevant background factors, time of immigration, number of persons eligible for screening, acceptability of screening, number and time of screenings performed, screening completion and yields is needed (Figure 2). For asylum seekers, the centralized procurement of healthcare services provides a feasible option for data collection (III). However, multisectoral collaboration between public health professionals, immigration officials and private and public sector healthcare providers is necessary in order to transform the data to inform public health decision making.

Health literacy is a prerequisite for healthy behaviours and practices such as participation in screening and vaccinations and condom use. Adolescents and young adults are recognized as a key population for prevention of blood-borne and sexually transmitted infections in Finland. First-generation migrants might have not been exposed to health education in their countries of origin and might not be familiar with the use of the healthcare system and their entitlements to care in the CCOR. Results from this study demonstrate that young adult asylum seekers have important gaps in HIV-related knowledge in comparison to young adult general population, and that there are cultural differences in preferred sources of SRH information (IV). The

kind, quality and effectiveness of civic information provided to resident immigrants and asylum seekers should evaluated in Finland.

In addition to barriers to screening, migrants have been reported to have problems in accessing care and achieving optimal treatment outcomes. In order to ensure the continuum of care for migrants, these individual, social and structural barriers should be addressed.

6.6 STRENGTHS AND LIMITATIONS OF THE STUDY

This thesis is the first comprehensive assessment of the epidemiology of hepatitis B and C, HIV and syphilis among different migrant populations in Finland. Using a multimethod approach, the study examined the performance of different strategies for prevention and early diagnosis of infections among migrants. The study lays the groundwork for further research and policy development on infectious disease control among migrants in Finland.

To increase the external validity of the results, the study included population-based samples of major resident migrant populations (I, II) and general young adult populations (IV) as well as a total population sample of all asylum seekers in Finland during 2015–2016 (III). Non-participation analysis revealed no difference in infectious disease notification prevalence among participants and non-participants in the Maamu survey (I). Nevertheless, a participation bias is likely to occur as survey participants might differ from non-participants with respect to characteristics that are not measured in the survey. The influence of participation bias is strongest in the TIE survey that applied convenience sampling (IV).

Survey data also has response and recall biases (I, II, IV). Anonymity and computerized responses in TIE and WAD 2014 surveys respectively may have decreased the social desirability bias (IV). One-sixth of young adult asylum seekers in the TIE survey were unable to read well in their mother tongue and they might have needed interpretation to complete the questionnaire, which might have influenced the results.

Population-based seroprevalence surveys are scarce and they provide valuable information on the prevalence of determinants for health in the general migrant populations [21, 140]. Some information on migrant specific vulnerabilities to hepatitis B and C, HIV and syphilis was not collected in the Maamu and TIE surveys (MSM, sex work). Additionally, future assessments should also consider determinants of migrant health such as sexual mixing and imprisonment. Furthermore, associations of determinants for health and health outcomes observed in cross-sectional settings do not imply causation. This is especially relevant for studies aiming to evaluate the temporary relationship between migration and infection [21].

Testing seropositive for HBsAg, HCVAb or TrpaAb was a rare event in the studied migrant populations reflected by the broad confidence intervals

around the point estimates especially after stratification (I). In order to establish the relationship between infection prevalence and various determinants for health, such as age, larger population samples are needed. For this purpose, national steering and organization of asylum seekers healthcare provides an opportunity [4,15]. However, increasing the sample size does not necessarily remove the uncertainties related to sparse data.

Our results demonstrate that surveys complement register data and can be used to describe the risk factors and burden of missed infections among general populations. Other sampling techniques, such as snowball recruitment, might be more beneficial in collecting information on specific risk groups, although they are not able to estimate the size of the total population [2,94].

Infectious disease register data is limited to the population that has been tested, diagnosed and notified in the register. Quality of register information is influenced by the sensitivity, specificity, representability and accuracy of the data [5]. Only cases that fulfil specific case definitions are included. Differences in register case criteria and incompleteness of information on immigrant backgrounds hamper attempts to compare infectious disease incidence among migrants between countries [4, 416].

The NIDR case criteria for CHB, CHC, HIV and syphilis differ slightly from those adopted by the ECDC and the CDC [395, 396]. The main difference in the surveillance case criteria is related to a lacking requirement for follow-up and control specimens in the NIDR, resulting in possible overestimation of the number of CHB, CHC, HIV and syphilis cases. On the other hand, considering hepatitis B and C, and syphilis diagnoses that reoccur within fifty years as single cases in the NIDR might underestimate the number of recurrent infections.

Migration background in NIDR is derived from physicians' notifications and through register linkage to PIS. Difficulties in merging notifications among temporary visitors, such as tourists, asylum seekers and migrants in irregular situations reported with temporary PICs into single cases might result in overestimation of the number of cases. Furthermore, prediction of the number of infected persons currently living in Finland based on NIDR is prone to overestimation since emigration information from the PIS is rarely available. Quality of NIDR with respect to migration parameters has not been evaluated. Previous studies also suggest possible misclassification of risk factors and routes of transmission among migrants [94].

The procurement register data of asylum seekers health services did not allow for the stratification of seroprevalence rates in population sub-groups by country of origin or sex. The seroprevalence rates are likely to differ considerably between migrant population sub-groups. Also, the data for the numerator (number of screenings performed) and denominator (number of asylum applications registered) were derived from different sources. It is unlikely, but possible, that a small proportion of the screenings might have been procured from other service providers than the two national private

providers supplying data for the study and thus the coverage estimates could be underestimates.

Moreover, the data cannot differentiate between screening tests and test performed due to other indications. There were more HBsAg tests than TrpaAb tests performed among asylum seekers (22,144 and 22,016 tests respectively; Table 9), suggesting that 0.6% of HBsAg tests were performed due to an indication other than screening. Persons tested outside screening guidelines might differ from the rest of the population with respect to risk factors for infection.

Migrant populations are heterogeneous. This study examined specific first-generation resident adult migrant populations and asylum seekers in Finland. Although Kurdish, Russian and Somali-origin migrants represent the third, first and fourth largest migrant populations in Finland, respectively, together they accounted for only one-third (33.2%) of the total number of first-generation migrants in Finland in 2017 [30].

Migrants from Estonia (second largest group), China (fifth) and Thailand (sixth) all have very specific risk profiles for blood-borne and sexually transmitted infections. Estonia has the second highest HIV notification incidence among EU/EEA countries and an adult HIV prevalence of 0.7% in 2017 [133, 136]. HIV prevalence in Thailand is estimated at 1.1% [133]. Migrants from South and South East contributed for 5.0% of the HIV cases among migrants and 1.9% of all cases during 2007–2011 in EU/EEA [4]. During 2015–2016, 7–18% of residency permits in Finland were granted on the basis of refugee status [417-420]. Hence, the results of the study cannot be generalized to all migrant populations in Finland.

Limitations of HBsAg, HCVAb, HIVAgAb and TrpaAb seropositive findings should be kept in mind. HBsAg negative persons can be susceptible for infection, have resolved the infection spontaneously and developed natural immunity, or vaccinated. In order to understand the proportion of migrants who would benefit from hepatitis B vaccinations, an assessment of HBcAb and HBcAb seroprevalence rates should be conducted.

HCVAb-positive persons should be tested for HCV-RNA in order to conclude CHC diagnosis. HCVAb-positive and HCV-RNA negative individuals should be counselled, and if presenting simultaneous risk factors for HBV, offered HBV vaccinations. A recent infection with HCV can test HCVAb negative.

Establishing syphilis diagnosis among TrpaAb-positive individual requires further testing, patient history and clinical examination. Considering that treponemal tests for syphilis screening were commonly adopted in Finland only after 2005, some missed TrpaAb cases in the Maamu survey might have actually been screened before 2005 with non-treponemal tests [88]. In fact, seven out of eleven TrpaAb-positive cases in the Maamu survey had immigrated before 2005.

7 CONCLUSIONS

Based on observations from this study, the following conclusions may be drawn:

1. Screening for hepatitis B and C, HIV and syphilis is feasible in migrant population-based health surveys and does not deter survey participation. High acceptability of multiphasic opt-in provider-initiated screening of hepatitis B and C, HIV and syphilis among migrants of Kurdish, Russian and Somali origin should encourage health professionals to actively offer screening. Appropriate pre-test counselling can further increase test acceptance. (publications I and II)

2. Seroprevalence rates of hepatitis B and C, HIV and syphilis differ among different migrant populations and asylum seekers in Finland, but they seem to be lower or comparable to in-country populations and migrants in other high-income countries. Russian-origin migrants, the largest migrant population in Finland, carry a large burden of infections that is not addressed by the current selective screening among forced migrants. Moreover, hepatitis C screening among at-risk migrants is currently not included in the national screening guidelines despite of evidence supporting cost-effectiveness. To address this burden, strategies to expand after-arrival screening of hepatitis B, HIV and syphilis to all migrant populations at-risk and inclusion of hepatitis C screening should be adopted. (publications I and III)

3. Missed hepatitis B and C and syphilis diagnoses among Kurdish, Russian and Somali-origin migrants, suboptimal coverage of screening among screening eligible asylum seekers and observed rates of previous HIV testing suggest barriers to services among different migrant populations in Finland. Coverage, as well as other elements contributing to screening effectiveness should be monitored, and gaps identified and addressed. For asylum seekers, gaining residency and entitlement to municipal health services provides an opportunity to increase screening coverage. Missed hepatitis B diagnoses among Somali-origin migrants suggest missed opportunities for vaccinations. Screening of hepatitis B should aim both at identifying infected individuals for follow-up and treatment and uninfected persons at-risk for hepatitis B, who would benefit from hepatitis B vaccinations. Missed diagnoses among Russian migrants and missed hepatitis C diagnoses in all investigated migrants demonstrate that current opportunistic screening approaches do not compensate for lacking screening programme. (publications I, III and IV)

4. Gaps in HIV-related knowledge both among young adult asylum seekers and young adult general population might dispose these groups to risky behaviour and HIV. Approaches that are accepted by young people need to be designed and implemented. The asylum process is a window of opportunity for health promotion. (publication IV)

7.1 SUGGESTIONS FOR FURTHER RESEARCH

1. Recognizing migration as a global megatrend and acknowledging migrants' vulnerabilities to blood-borne and sexually transmitted infections, migrant health and infectious diseases should be included on the public health research agenda. Public health institutes and universities should provide guidance for strategic research in migrant health and information needed for evidence-informed decision making. Non-academic organizations such as NGOs should be included as active partners in research and development.

2. A comprehensive evaluation of time, location and population-specific epidemiology of the key blood-borne and sexually transmitted infections among migrants in Finland, including estimation of the proportion of post-migration infections, should be conducted. The evaluation should aim at identifying pockets of especially vulnerable migrants and provide suggestions to reach these populations.

3. Surveillance of hepatitis B and C, HIV and syphilis among migrants should be strengthened with respect to the migration parameters in the NIDR and through linkage with the PIS in harmony with the European framework [416]. Case criteria for infections should be harmonized with regional and global public health institutes and made publicly available for clinicians and researchers using NIDR. Quality of NIDR should be evaluated.

4. Infectious diseases assessments should be included in future population-based surveys, and resources for screening should be ensured. Future surveys should attempt to include migrants from various countries of origin and also from the second generation. Prospective register studies based on the population-based surveys could provide more information on the risk factors for infections.

5. VFR and other travel among migrant populations should be described and infectious disease risks among travel assessed.

6. An assessment of HBsAg, HBcAb and HBsAb seroprevalences among key migrant populations should be conducted to evaluate the coverage of targeted hepatitis B vaccination strategy.

7. Different strategies and best practices in reaching and providing civic information and SRH education for different migrant populations in Finland should be mapped and evaluated for effectiveness using mixed methods approaches.

7.2 OPPORTUNITIES FOR PUBLIC HEALTH RESPONSE

1. Acknowledging the current trends in migration and epidemiology of hepatitis B and C, HIV and syphilis in Finland, a coordinated public health response should be implemented based on previous experience [154, 333, 421].

2. Healthcare providers should acknowledge the high acceptability of provider-initiated multiphasic screening for blood-borne and sexually transmitted infectious diseases. Approaches to facilitate screening offers among healthcare staff should be adopted, including training, multiphasic laboratory referrals, and assisted decision making. Health providers should acknowledge that infectious disease risk-assessment should be based on a comprehensive evaluation of risks at individual level and take into consideration the determinants for health along the migration cycle (Figure 1).

3. Acknowledging the international consensus on public health benefits of HBV, HCV and HIV screening among migrants and burden of syphilis among specific migrant populations in Finland, opportunities to expand current after-arrival screening to other at-risk migrant populations besides refugees and asylum seekers should be evaluated. Exploiting existing screening strategies, such as the ANS, could be beneficial.

4. Taking into account the recent advances in HCV treatment, the cost-effectiveness of expanding hepatitis C screening to refugees and asylum seekers in Finland should be evaluated. Existing organization of initial health services among refugees and asylum seekers and adopted multiphasic provider-initiated opt-out screening of CHB/HIV/syphilis could facilitate the introduction of HCV screening.

5. Acknowledging the substantial proportion of missed hepatitis B infections among Somali-origin migrants, the cost-effectiveness of expanding hepatitis B vaccinations to all HBsAg negative first and second-generation

migrants originating from countries with high CHB prevalence (>5%) among the general population as well as benefits of screening for protective immunity in conjunction with HBsAg should be evaluated.

6. Systems and tools to monitor infectious disease screening effectiveness among migrants should be developed and adopted in collaboration with other stakeholders such as immigration officials, municipalities, regional governments, and private healthcare service providers. Monitoring data can be used to close gaps in implementation of screening.

7. Barriers to opportunistic self-initiated screening for blood-borne and sexually transmitted infections should be lowered by ensuring the availability of free and anonymous screening within the public healthcare system, providing sustainable funding for low-threshold services, enabling community testing by non-medical staff, as well as self-sampling and self-testing.

8. Health education concerning blood-borne and sexually transmitted infections among young people should be strengthened in coordinated collaboration among teachers of primary and secondary level schools, parents, NGOs and public healthcare. Asylum-seeking young people can be reached also through reception centres. Appropriate and youth-friendly methods of delivering the health messages should be used.

9. A continuum for care from prevention to diagnosis and treatment of hepatitis B and C, HIV and syphilis should be ensured for all migrants irrespective of immigration status.

10. The public health response to hepatitis B and C, HIV and syphilis epidemics among migrants should acknowledge existing discriminatory structures and practices, racism and stigma, and strategies to eliminate these should be adopted. Migrants do not pose infectious disease threats to society but are themselves vulnerable to infections. Migrants should be involved in the development process.

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TABLES AND FIGURES

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